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THE TECHNIQUE OF RESEARCH IN EDUCATION

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PREFACE

This book is the result of the writer's conviction that the progress of research might be accelerated if those who engage in it possessed a little more training in its technique. Such training as graduate students get in research technique is largely of an incidental nature, except in the case of a few who take courses in statistical or historical method. The writer believes that much could be done in a more direct way as a preparation for later individual work.

The author's hope is that this book may be used as a textbook in a regular course in the senior or graduate year, in preparation for entrance into graduate study and research. Allowing for seventeen effective weeks in the semester, the course would deal with one chapter a week, together with extensive supplementary reading and study in the library. In this way each student should get acquainted with the leading authorities on each type of research and the principles involved in it. In addition to this study of the fundamentals by all students in the class, the author suggests that each student might be expected to do two other pieces of work of an individual character. He might be expected to prepare a comprehensive paper based on very extensive reading about the particular type of research in which he expects to engage, and also to do an actual piece of research employing that technique. If the student is a graduate, this piece of research might be the beginning of the thesis, or it might be merely a preparation for it.

The material included here has been assembled by the

following processes: *First,* a complete difficulty analysis was made by having graduate students report those difficulties which they had encountered, and by having professors report those which they had experienced or observed in research workers, and by examining about one hundred theses for their shortcomings, defects, and implied difficulties. *Second,* these difficulties were classifield into types and formulated into questions beginning with the word "How". There were 145 such "How" questions, each representing a research difficulty. *Third,* all methods that could possibly be found for solving each of these difficulties were collected. These methods were drawn from about one hundred graduate students, a few professors, numerous books and articles about research, and scores of published and unpublished research reports. Each method, when found, was written on a small card and given the number of the difficulty of which it was a solution. *Fourth,* the cards were classified and arranged according to content, and their contents written in textbook form, with a goodly mixture of the author's own thinking and evaluation of the methods presented. If the recommendations here made are not all sound, they will at least raise issues and stimulate thought.

Special acknowledgements are due to Dr. W. W. Charters for the technique used in assembling the material for the book, to Dr. W. S. Ford, for supplying material for the chapter on Survey Technique, to the various authors of books, articles, and theses from which suggestions have been drawn, and to the many graduate students who supplied their lists of difficulties and methods.

C. C. CRAWFORD.

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THE TECHNIQUE OF RESEARCH IN EDUCATION

CHAPTER I

SELECTING PROBLEMS

Two tasks confront the person who would begin educational research. He must, first, discover problems that need solving, and, second, he must judge the relative values of those he discovers. Each of these tasks will be discussed in this chapter.

I. Finding Problems

If every person who wished to engage in research could come to his professor or director with his problem clearly formulated, and his plans for attacking it already made for approval or revision, this would be ideal. More often, however, the candidate for research is faced more urgently by the need of doing *something* than by any definite problem that he wishes to solve. The search for a problem or the discovery of an issue which needs investigating can be made more productive by employing refined or systematic procedures. Blind searching is more desirable in this case than in the case of searching for objects of a material nature. The following paragraphs are intended to assist in the process of discovering problems that lend themselves to scientific investigation:

1. Deriving a problem from a vocational choice. The person who has selected as a life work the teaching of English, the administering of a high school, or the handling of an adjustment room, is already in an excellent position to select a thesis problem. On the other hand, one who does not know whether he will teach history or mathematics is sometimes not ready to make the decision on a thesis problem. A piece of research has a double relationship with one's vocation: (1) It will be a better piece of research if it fills a vital professional need. (2) It will contribute more to future professional growth and development if it is in the general field that is to be followed as a life work.

2. Specializing in the field to be followed. There is actually such a thing as being too ignorant to ask intelligent questions. The person who knows nothing about education will likewise find difficulty in discovering the vital issues that demand further study. Certainly no one should attempt to explore the unknown and uncharted areas in education until he has acquired a reasonable familiarity with what is the common knowledge of well-informed educational workers. Occasionally this is done, with the result comparable to discovering the "new" principle of the bow and arrow in this modern age of machine guns and heavy artillery. Anyone who hopes to engage in research, whether for an advanced degree or not, should, in justice to himself, acquire a reasonably thorough foundation in the ordinary subject matter of the field in which he ultimately hopes to do his work. Such a foundation makes it easier to perceive the issues and to judge the importance of problems that present themselves.

3. Analyzing a field or topic into its parts. Almost any educational topic, if reduced to its elements, would

break up into hundreds of excellent research problems. The beginner is usually acquainted with the major topics, such as supervised study, project method, socialized recitations, etc., and not uncommonly attempts such a topic instead of a problem. These topics are unsatisfactory because they are in too large units to be attacked as such. A little analysis has not only the advantage of reducing the size of the unit but also that of enormously increasing the number of units or parts which may be followed up as research problems. It has been the writer's experience that most thesis problems were arrived at by subdividing much larger topics into their parts rather than by the opposite plan.

4. **Extending term papers.** It is customary in most advanced courses and in graduate seminars for each student to be asked to prepare a long paper on some subject connected with the course. While these papers are usually not of a research nature, they are nevertheless an excellent preparation for a thesis in that they are exploratory and help to discover the problems that are involved in the field. A good policy for an advanced student who is about ready to begin research is to select several *topics* in which he is somewhat interested and to write a term paper on each in a different course; then to narrow one of them down to a thesis *problem* to be attacked by scientific research methods.

5. **Providing research contacts.** It is fairly safe to judge a man by the company he keeps. Particularly is this true in research. A person who is interested in research will do well to enroll in courses with kindred souls and under professors who have a spark of the research fire in their hearts. There is in the usual college faculty at least one man who is especially interested in research and scholarly production. He may not

be the best teacher nor the most interesting personity on the campus, but his interest in research is strong and his power to inspire and to direct scientific work is great. The would-be research worker should find such a man and study under his direction. This usually involves enrolling in a graduate seminar, a veritable nursery for research workers. Such definite and formal contacts with persons interested in research can not help contributing greatly both to the discovery and the solution of research problems.

6. Meditating. One way to discover research problems, but a rather poor way as a rule, is by simply meditating. To dwell on the need or desire for a problem long enough is likely to cause one to arise in the mind. Some active or systematic plan of attack, or some purposeful search for a problem, is much more likely to produce results. The most fruitful results of meditation are derived when it is employed in evaluating problems after several possibilities have been definitely formulated. An active search for several problems, followed by a period of "soaking," or meditation, is to be encouraged.

7. Analyzing popular superstitions. The history of science has been a long succession of blasting of popular superstitions. Copernicus discovered that the earth moves instead of the sun; Columbus demonstrated that the earth is round and not flat. Yet for years after these discoveries the masses clung to the older beliefs. Similarly, in our own day we find scores of popular superstitions about biology, psychology, sociology, education, etc., which are still cherished by the multitudes. The popular mind refuses to believe that dogs do not reason, or that study does not produce a general mental discipline. Any one of these issues, which may be

thought of as skirmishes between the scientist and the layman, would furnish an excellent thesis problem. If the masses are right, we should know it; if they are wrong, the more facts that are made available, the more likely are they finally to see the light and accept the scientific view.

8. **Particularizing feelings of discontent.** There is probably no one who is entirely satisfied in every way. Even the best teacher or administrator is likely to be unhappy about something. The trouble with most people, however, is that they have not taken the trouble to sit down and decide exactly what they are displeased about. The lower animals are said to be unable to distinguish consciously the difference between the promptings of such impulses as hunger, thirst, cold, sex, and pain, and simply become so restless under one of these stimuli that they stir around until they happen upon suitable sources of relief or satisfaction. In contrast with this blind and aimless method of remedying our troubles, scientifically trained research workers think the situation over or make a definite analysis of it until the exact source of irritation or annoyance is located, and then set up the necessary procedure to correct it. Each cause of discontent is a potential thesis problem.

9. **Making an analysis of difficulties or deficiencies.** "They that are whole have no need of the physician, but they that are sick." The greatest need of research is in those phases of endeavor which are falling short of the mark. A principal who wishes to encourage research in his school has only to note where the school is weak, faulty, or deficient to find a multitude of research problems. The classroom teacher needs only to look over the red marks she has put on a set of papers

to discover a host of research problems dealing with the learning process and methods of studying employed by her pupils. Every difficulty or deficiency is a potential research problem.

10. Observing educational practice. To watch a teacher or student at work for an hour should raise in the mind a number of problems for intensive study. The observation will bring to mind several unsatisfactory elements, several elements of unusual merit, or several matters that call for further interpretation. A few days devoted to observation and visitation of actual classrooms should raise in the mind such a number of questions that the difficulty would no longer be in finding *a* problem, but in deciding *which of several* problems to follow up. If this plan were employed more frequently by research workers, there would be fewer purely abstract investigations and more genuine solutions of the vital issues now troubling educational practitioners.

11. Listening with a critical attitude. What people say is usually less carefully thought out and less thoroughly considered than what they write. Even scientists of some repute who would not publish mere opinions dogmatically will sometimes speak them orally with an air of absolute finality. The person of less training is even more prone to say what is on his mind without taking the trouble to examine its truthfulness. The result is that lectures, round-table discussions, and class recitations afford an innumerable supply of possible thesis problems, because almost every sentence that is uttered is likely to contain something that is unproven and therefore in need of further investigation. Listening to an ordinary argument should suggest to a scientific mind very quickly what

essential facts are needed by the contestants, or what investigations would be required to settle the issue. Most lectures and class discussions involve an element of argumentation, and every subject that lends itself to argumentation is at least a possible candidate for scientific investigation.

12. Reading research reports. Research begets research. One man's investigation inspires and suggests scientific work on the part of others. To read what another person has done on a given problem helps to see the issues and to decide upon a phase of it for one's own study. To read several theses or published articles of a scientific nature will almost certainly help in making a choice of a problem. Most graduate schools have, in addition to the theses produced by their own students, more or less complete files of the Columbia University doctors' dissertations. A few days spent in reviewing these would be worth the time of any graduate student who is getting ready for his own thesis study. Not only does the reading of such works contribute greatly in making clear the nature of scientific work, but also in suggesting the further work that needs to be done on each of the problems that have been investigated. To take up any ordinary thesis problem and apply to it the remaining procedures which the previous investigator overlooked or omitted would constitute on entirely satisfactory thesis undertaking.

13. Reading current periodicals. There are two reasons why educational periodicals are especially helpful in the selection of research problems: (1) They are of a research nature to a greater extent than books. Books, as a rule, present the thoughts of their authors, whereas the periodicals present the facts

derived from investigations. For this reason a person hunting a thesis topic will profit more by going through periodicals than by going through books. (2) Periodicals are more recent than books. Books are often out of date by the time they are published, and hence do not suggest the newest things in educational science. Periodicals, however, present what is on the very "firing line" of educational activity. Since research is by nature something of a pioneer or frontier work, it is especially important to move up to the frontier to begin, by reading what is going on at the time. Without reading the journals a student cannot be sure that a proposed problem has not already been solved by another investigator, or outgrown by the march of events.

14. Reading textbooks critically. The usual textbook in education is only partially based on scientific data. Research has not gone far enough to provide data for guidance on matters of educational practice. But textbook writers cannot wait. They are obliged to provide something for the training of the new generation of educational workers, and in the absence of science they are forced to resort to common sense or empirical advice. To read a textbook on methods, administration, or educational psychology with this point in mind should suggest a host of problems for investigation. Each chapter title might be considered a thesis topic and almost any paragraph or sentence in the chapter might be made into a thesis problem. The chief essential is that the reading be done not from the viewpoint of assimilation but of investigation or critical searching for points which are stated without scientific verification.

15. Using questions and exercises in textbooks.

Most textbooks have some kind of "questions for further study" or "topics for investigations," etc., at the ends of chapters, which are useful as a source of research problems.

16. Consulting bibliographies of scientific materials. To look over a list of titles of theses accepted by any graduate school, or to note the titles of research articles published during a given period, in an excellent way to discover problems for investigation. The United States Bureau of Education occasionally publishes in bulletin form bibliographies of research under way or completed. The Phi Delta Kappa educational fraternity publishes in its official organ the titles of masters' and doctors' theses accepted during the current year at the various institutions which have fraternity chapters. The Educational Research Association has a policy of preparing a summary of bibliography of educational investigations at intervals. All such lists of research endeavors have splendid possibilities in suggesting problems for scientific study. The mere fact that some one else has undertaken a given study does not eliminate it from the list of possible thesis subjects. It simply indicates that someone has opened up the field for others who are to come later and cultivate it more thoroughly.

17. Deriving problems from procedures. The possession of a certain tool stimulates the search for something upon which to use it. A boy who has a hammer and saw will think of something to make with them, just as a boy who wishes to make a birdhouse will search for materials with which to make it. Many research problems are chosen in this way. A person who has an excellent training in statistics will consequently find a problem that will utilize the avail-

able tool. Another who has had training in methods of historical research will turn his energies upon a historical problem. It is not at all amiss to examine the various types of research procedure which are available and to select a thesis problem that grows out of one of these types. Procedures naturally suggest problems, and sometime they do so to a greater extent than problems suggest procedures.

18. Assembling several problems from which to choose. To choose a problem from a large number of possibilities is preferable to taking the first one that presents itself. A good plan is to provide a sheet in the notebook headed "Research Problems" and to write down one whenever it comes to mind. After a period of time the collection will be comparatively large and the selection of the best one will be a matter of small difficulty. Unless such a collection of possibilities is made, some of the best problems that have occurred to the mind will have been forgotten by the time of the final decision, and will be completely overlooked. It is difficult to judge anything except by comparison, and the greater the number of other items with which to compare it, the more nearly perfect is the judgment made.

19. Reading intensively on the problem tentatively selected. After a problem has been discovered which seems to meet the requirements for a thesis, the next step is to confirm or verify the selection by further study upon it. It is necessary to read and think about it enough to find what factors are included in it, what difficulties are presented, and what special conditions or circumstances will be required for its completion. By reading what other investigators have done on the same problem, it is possible to judge whether the diffi-

culties can be overcome and whether it can be carried through to completion. It is better to make such a survey of the field at this stage than to rush ahead blindly and then have to give up the undertaking after weeks or months of effort have been expended.

20. Conferring with faculty members. Almost every professor in a graduate school has in mind one or more vital issues in his subject or field which need investigation. It is not uncommon for faculty members to have prepared lists of research problems that center around some special interest and which, taken as a whole, constitute a rather complete and exhaustive analysis of that one field. Since research is by nature somewhat opportunistic, it is often better to take a problem of this type, which is only a part of a much larger problem in which the professor is interested, and to work on it in company with numbers of other graduate students, than to choose one of an isolated type and work apart from the others. There is yet another reason for conferring with the professor in choosing a problem. The beginner usually lacks perspective and foresight, and is likely to judge poorly the merits of a problem. As a corrective for this fact it is necessary to consult some one who can see more clearly the issues involved before finally making a selection.

21. Letting the first problem grow. There is seldom any difficulty in finding or selecting a research problem after the first investigation is completed. A master's thesis is almost certain to suggest a dozen or more suitable problems for a doctor's dissertation. The more research a person does, the more problems he sees that call for investigation. Getting started on the first problem may be somewhat difficult, but this should

not cause discouragement or deter one's entrance upon a research career, because it is a difficulty that does not often present itself again.

II. Standards for Judging Problems

The making of a final choice after several possible problems have been found is a matter of no small difficulty or importance. Several matters have to be considered, and the great danger lies in basing a decision on only a few of the many elements involved. There is need for something in the way of a score-card or set of standards for estimating the desirability of problems for research. The following paragraphs discuss some of the items which might well be considered in such a situation:

1. Scientific character. Dr. Judd has called attention to the difference between studies which are primarily research and those which are primarily service.* There are many things which can be done that involve accumulation of data, tests, making statistical calculations, etc., and which nevertheless are not research because they are simply doing something with present knowledge. Giving tests and teaching classes are worth-while activities, but are not research because they do not involve discovery of new truths or contributing to educational science. The student should examine the strictly scientific character of the research problem, asking always the question, "What new knowledge will its solution add to the world's present supply?" rather than "How much immediate service will it render in a particular educational situation?"

2. Fundamental importance. Some researches lead

*Address delivered at a meeting of the Phi Delta Kappa fraternity.

to real inventions; others are merely tinkering with inventions previously made. Some affect the major channel of the stream of human progress; others merely cause minor eddies in the stream. Some discoveries will affect a few individuals in rather important ways and not touch the masses; others will actually change the daily behavior of millions of people. The importance of a scientific investigation may be measured in two principal ways: First, how much territory or how many people will be influenced by it? Second, how much will these people be influenced? To raise the level of the ocean one inch would be a more important achievement than to raise the level of a small pond a yard.

3. **Facilitation of other research.** The solving of a problem should pave the way for the solution of still other problems. It should suggest new problems and clear the atmosphere so that they may be examined with greater precision than before. It may result in a new tool or technique, or a new method of analyzing data that can be used in attacking numbers of other problems. This point may be illustrated by comparison with a street car system. Some problems are like inbound cars which connect with dozens of other cars in the central traffic district, while other problems are like outbound cars which simply go to the end of the line.

4. **Unification of knowledge.** Some research undertakings are valuable in themselves, while others are valuable as connecting links between the former type. For example, Gray's "Summary of Reading Investigations"* is a scholarly piece of work whose major contribution lies in its being an inventory of other peoples'

*Elementary School Journal, XXVII, March, 1927, pp. 495-510.

work in this field. An investigation may be of great value simply by establishing a link between other studies or by correlating, coordinating, or unifying the results of previous research.

5. Timeliness. "Strike while the iron is hot" is an old proverb whose application to our present discussion is important. It means that some problems are undesirable for research because they have been outgrown or passed by in the march of educational progress. Every year some young enthusiast proposes to do what has been done hundreds of times already by previous workers, not knowing that he could find in a few hours of library work a more complete answer to his question than he would achieve after months of labor. There are, of course, some probems which, although old and much-worked, need to be reopened and examined in the light of more recent developments. However, one who takes such a problem should do so consciously and not in ignorance of its status. There is also an opposite side to the factor of timeliness, in that some problems are premature. It is possible to get a problem for whose solution the world is not ready. The present supply of knowedge in certain fields is so limited, and the available tools or instruments are so crude, that it is necessary in such fields to undertake research of the "scaffolding" type, getting ready for more ambitious undertakings later.

6. Definiteness. A very desirable quality in a research problem is that which enables the investigator to know when he is through. The writer has known graduate students who were wondering when their professors were going to tell them to stop, who were doing their work very much as day laborers, and for whom there was no definite end to the task. Such

is most unfortunate. If a problem cannot be so definitely formulated at the outset that a good idea of the goal can be obtained, it had better never be attempted. Even Columbus had a goal when he set out on his epoch-making journey, and the average graduate student who attempts to explore unknown realms of knowledge should have a pretty clear idea of the goal ahead of him.

7. Unity. The common tendency of untrained research workers is to include too many things in the problem. They start out with a fear that there will not be enough material to fill the required number of pages, and, consequently, try to cover a field large enough for ten or a hundred theses. They struggle with this great variety of problems and facts in a superficial way for a period sufficient to have solved one of the problems well, and then either quit in disgust or dress up what they have and hope to get it accepted. If they succeed, they sigh in relief and rejoice that their research careers are ended. It is almost impossible to overemphasize the need of analyzing the problem down to a *unit* and then solving that one problem. This makes for small and minutely specialized theses, but the day is past when any other kind will have much value. Any single unit, if properly attacked and persistently followed up, will grow to such proportions and gather such significance as to satisfy any normal cravings of the investigator for importance and respectability. A minutely specialized investigation is by no means a trivial or worthless one. On the other hand, the worthless studies are much more commonly those which undertake to cover the whole field and analyze several factors rather than to exhaust the possibilities with a single unit.

8. Feasibility. How to prevent crime is a very worth-while problem, but one which the average research worker would do well not to attempt, because of lack of access to data, and lack of opportunity for experimentation. A problem must be judged in the light of the facilities available for attacking it. It must be selected for a particular person and a particular situation. Before committing himself to a problem, a student should draw up a detailed outline of the procedure required to solve it, and unless he can see through to the end, he should not attempt it. One caution should be observed at this point, however. A good problem should not be abandoned merely because a plan of solution does not automatically present itself. Feasibility is achieved by *making* the necessary conditions as often as by *finding* them. There are ways of attacking a great many problems that are not obvious at first glance, and the true scientist will not abandon his problem on grounds of feasibility until he has demonstrated to his entire satisfaction that it cannot be solved.

9. Practical value to society. All research should ultimately be practical or useful. Knowledge for its own sake may be permissible at times, in the sense that its practical utility at the time may not be visible, but the ultimate goal should be knowledge for the welfare of mankind. In judging a problem one question that should be asked is, "What contribution will it make to society?" or "How much will it improve social practice?" Not only should a problem have some potential worth to society, but it should have *more* worth than others which are discarded in its favor.

10. Personal returns involved. Until the time comes when research is recognized as a public service and

paid for just as is teaching or entertaining or healing the sick, the research worker will have to give considerable thought to the personal rewards he is to gain from his work. This does not mean, however, that he is to consider purely the financial profit that comes from the work, for there are ordinarily considerably greater rewards of other kinds than the financial. One reward to be considered is that of increased training. Not every problem will give equally valuable practice in specialized techniques which make for future productiveness. A second form of personal reward is professional growth and development. It is well to choose a problem with a forward look, thinking of a whole career rather than the immediate necessity of meeting a degree requirement. To fail to consider the relation of a research undertaking to one's future professional career is comparable to studying for an examination with no intention of remembering anything after it has been passed.

11. Freedom from prejudice. If the main point of a certain problem is to *prove* something, it should be abandoned. If it is one upon which the investigator has a strong hobby, he will be unable to pursue it scientifically. A mother is unable to see the shortcomings of her own children, however obvious they may be to the neighbors, and an investigator is unable to think clearly and draw conclusions wisely about the project or pet scheme that is dear to his heart. Before starting on a problem, it is well to ask, "Is this a problem upon which I am open-minded and about which I can fearlessly face the truth?"

12. Previous preparation required. A good problem for one person may be absolutely unsuited to a person of different experience and training. A person who

has not had statistical training should by no means undertake statistical problems, and lack of historical training would bar any attempt at preparation of a thesis of the historical type. Persons who have had teaching experience are able to take up certain problems which inexperienced persons could not hope to solve successfully. A thesis problem should be selected only after a careful analysis of the amount and kind of previous preparation it presupposes.

13. Interest. Other things being equal, that problem is best which holds the greatest interest for the investigator. There are several ways to fulfill this requirement in selecting a thesis problem: (1) Assume a large share of the responsibility for selection of the problem instead of putting it upon the faculty director. (2) Read extensively about the problem before finally selecting it, in order to see what it involves. Research is like marriage in that thorough acquaintance beforehand may save many regrets later. (3) Start with the main dominant interests and work toward the thesis problem. For example, an English teacher would begin the search for a thesis problem within the field of English. (4) Read research reports and select problems similar to those which prove most interesting. (5) Choose one arbitrarily and get interested later. A research problem does not prove interesting in the same way as a motion picture show. Its interest grows out of constant association and mental application upon it. It is possible to get interested in almost any problem. (6) Derive interest from the procedure employed in addition to the problem itself. It is possible to make almost any problem interesting by being resourceful in setting up methods of attacking it.

EXERCISES AND QUESTIONS

1. In what sense is it true that the genuine research worker has no difficulty in finding a problem?
2. Why does a research director usually dislike to assign a problem for a thesis?
3. Using the present chapter as a source of suggestions, list as many research problems as you can think of.
4. Apply to the list sugested in 3 above the standards outlined in the second half of this chapter.
5. Describe your state of mind when you first began to consider the choice of a research problem.
6. Arrange in the order of their value the methods of finding problems mentioned in the first half of the chapter.
7. Do the same for the standards described in the second half.
8. If you have done a piece of research or selectd a problem, tell how you made the selection.
9. Read in other books and articles on research and prepare a short paper or outline on "Selecting a Research Problem."

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Has several chapters which relate to the selecting of research problems.

CHAPTER II

EXPERIMENTAL TECHNIQUE

1. Nature of the experimental method. The experimental method has in recent decades come to be the backbone of science. Originating as a form of logic, or as a method of thinking, rather than as a definite and systematic procedure, it has now reached the stage where it is recognized as probably the most essential instrument available in the quest for truth. In its bare essentials, it consists simply of providing a situation where phenomena can be repeated and controlled, and then varying one element in the situation to see what variation in the result is thereby produced. This means the isolation of a single variable and the determination of its results when the other variables or elements in the situation remain constant. For example, if the growth of a plant is dependent upon several variables, as light, heat, moisture, soil, and cultivation, and the problem is to determine the part played by cultivation, the experimental method would be to measure growth under different forms of cultivation, being careful to avoid changes in amount or character of light, heat, moisture, or soil. If two of these elements are permitted to vary at the same time, it is then impossible to know which one is responsible for the variation in the result produced.

2. "Practical" versus scientific experiments. There is a great difference between experiments and experience. An experiment, in the scientific sense, involves a definite and conscious technique, with special atten-

tion to the measurement of results, control of the conditions, and the drawing of accurate and precise conclusions. It is far from a mere haphazard or trial-and-error procedure. A lower animal enclosed in a cage may "experiment" with methods of releasing himself, but not in the scientific sense. Likewise, many educational practitioners "experiment" with new methods of teaching or administration without taking the trouble to control conditions or measure results in any but the very crudest fashion. Such "experimenting" probably has much value, particularly as a contribution to the skill or art of the persons involved, but it usually adds little or nothing to educational science because the conclusions drawn are doubtful and the conditions are so poorly controlled that they cannot be repeated by others in exactly the same fashion. There is great need for more scientific experimenting such as is being done in the laboratory schools in large universities, in the place of the present "practical" or "rough-and-ready" experimenting now done by teachers and administrators who have had little scientific training.

3. Typical conditions. The conclusions from an experiment do not necessarily apply outside of the situation in which the experiment was performed. For example, an experiment on white rats does not necessarily hold true for human beings, nor does an experiment with adults necessarily apply to children. An experiment may be such as to create an entirely unusual, or even abnormal, situation in the classroom, raising interest to fever heat and producing spectacular results which would not appear in the normal classroom situation. Thorndike's experiments with animal learning have been criticised slightly because

he starved the animals to provide a motive for escaping from their confinement, and thereby may have produced an abnormal organic condition in them which affected their learning. Many educational and psychological experiments have been of doubtful validity because they were carried out under special conditions in the laboratory that were not typical of the classroom where the conclusions were expected to apply.

4. **Subjects.** The persons, animals etc., experimented upon are called subjects. An experiment is no better than the subjects involved. If they are improperly selected, the conclusions are vitiated. If they have a bias and have an opportunity to express it in their reactions, the experiment becomes questionable. They must be representative of the groups to which the experimental conclusions are to be applied and must be appropriate to the experimental factors or variables being tested. If the desire is to discover laws or generalizations about reading in the third grade, college students are not suitable subjects for the experiments. Nor is a class of honor students suitable for an experiment if the conclusions are to be applied to children of all degrees of ability. The number of subjects is also very important. It is better to use a very few subjects and control conditions thoroughly than to do superficial work with a large number. The ideal, of course, is to have careful work with a large number, but a compromise is usually required. As a rough working rule, it is fairly well agreed that for an experiment on human mental reactions, fewer than thirty subjects is likely to yield questionable results. On the other hand, having over one hundred subjects is likely to increase the labor at a rate disproportionate to the educational returns.

If an experimental program is to involve over one hundred subjects, it is well to ask whether it would not be better to do two or more allied and mutually supplementary experiments with fewer subjects involved in each. This, however, is a relative matter, and depends somewhat upon the nature of the problem. If the element to be measured is of a very delicate nature, it may be necessary to get very large numbers of subjects in order to get reliable results.

5. **Duration.** It is impossible to say definitely how long an experiment should continue. Much depends on the particular case. As a general rule, the tendency is to err on the side of too short a time rather than too long. A two-week experiment to determine the advantages of married life would hardly be valid, nor would a six-week experiment with a program of homogeneous grouping. Some of the results of an experiment may not mature until even years afterward, in which case a short-term procedure would overlook important results. It is much more difficult to judge a 100-yard dash than a mile run, because there is less time for the differences which exist to manifest themselves. If an experiment is allowed to continue long enough to produce a drastic change, or a big sampling of its results, minor errors will not be so serious. On the other hand, a long-term experiment would fail to discover certain things which are shown by a short-term one. For example, a one-hundred yard dash is in large part a measure of reaction time, or speed of starting, while the mile run is more a measure of fundamental body energy. The duration of the experiment will depend on what is being measured. Sometimes it is well to conduct a long-term experiment and to observe results at various intervals during the

period, thus combining one long-term experiment with a series of short-term ones.

6. Precision. An experiment may suffer from being either too precise or not precise enough. The totally untrained experimenter usually lacks precision, being satisfied with gross results only. He may even be content with qualitative results and not bother about quantities at all. The beginner who has learned something about the importance of precise methods, but who has not had enough practice to develop judgment in such matters often "stands up so straight that he leans backward," burdening his procedure with so many technicalities that the experiment breaks down from its own complexity. Sacrifices must be made somewhere in practically every experiment. If an airplane carried all the equipment, instruments, landing gear, parachutes, life belts, rafts, etc. etc., that might possibly be useful in a trans-Atlantic flight it would have no place for gasoline. Likewise, simplicity is a great asset in an experiment, but it cannot always be obtained without sacrificing precision, or omitting special techniques that would add valuable but not indispensable information. This is not a plea nor a justification for superficial work, but merely a suggestion for the application of common sense. Distances between cities are measured in miles, but the size of automobile pistons is measured in more precise units. The ideal is to adjust the degree of precision to the nature and importance of the thing being studied.

7. Individual differences. A perfectly controlled experiment on human subjects regarding mental behavior is practically impossible. It is next to impossible to be sure that such factors as interest, memory, intelligence, mental set, etc., are the same

for all subjects. In physics or chemistry the problem is much simpler. A piece of iron or a gram of nitric acid has the same properties and the same behavior as any other unit of the same substance. Consequently, any sampling may be considered truly representative of the class to which it belongs. But not so of human beings. No two are alike. What holds true for one may be only partially true for another, and absolutely false for a third. Experiments with human beings are made exceedingly complicated by this fact. An experiment on one person is of little value because he may be quite unusual. It is necessary, therefore, to experiment with several persons and then get some kind of average of the various individual results, which may be considered the generalization for human beings as a whole. This fact makes the choice of the samplings very important, and also calls for the use of more or less specialized statistical procedures to bring the various individual results together into some unified coefficient which expresses the uniformity running through all the cases.

8. **Planning.** The expression, "Fools rush in where angels fear to tread," applies to experimental research quite appropriately. The real scientist is not in a hurry to get started. He takes plenty of time to arrange the situation and to gain access to needed materials and equipment. There are several types of preparation which should be made before actually starting the performance of an experiment:

(1) Studying the rules of the game. Anyone undertaking experimental work should take time to educate himself with respect to its technique by reading articles and books about it. By far the best practical guide for this purpose now available, in the writer's

estimation, is McCall's *How to Experiment in Education,* which should be purchased and used as a manual by the research worker.

(2) Formulating a hypothesis. It is best to spend considerable time in thinking the problem through to a working hypothesis and then to make the experiment a test or verification of that hypothesis. More energy and thought at this stage make unnecessary much superfluous effort in manipulating test scores and statistics that do not contribute anything.

(3) Making a written plan. Formulating the proposed steps in the procedure in writing is an excellent method of planning for an experiment. There are so many elements and considerations involved that anythings short of a written plan is likely to be fragmentary and inadequate.

(4) Getting criticism of the plan. One person is never as likely to discover all the flaws in a proposed procedure as two. When the second person happens to be an expert in research work, as is usually the case with a major professor or research director, a conference over the first draft of the plans is almost certain to result in valuable improvements.

(5) Rehearsing the experiment with a small group. Writing and revising the plan involves a mental or imaginary rehearsal of the procedure, but it is usually desirable, wherever feasible, to carry it out on a small scale or with a few subjects, and to revise again before going into it finally for serious results. Almost every experimental research report mentions something in the nature of a defect or shortcoming that the experimenter discovered after it was too late. There will be plenty of these even after a preliminary rehearsal.

9. One-group procedure. McCall's *How to Experiment in Education* gives an excellent outline of procedure for three types of experiments: the one-group, the equivalent-groups, and the rotation experiments. For details of these types, the reader should consult that book. The present and the two following paragraphs will only attempt to touch some of the high points of each. The one-group procedure involves a single group of subjects and the application to that group of two or more variables in succession, all other conditions or variables being kept constant during the entire period. For example, if the purpose were to deter-

TABLE I

PROCEDURE FOR A ONE-GROUP EXPERIMENT

Period	Variable
I	1
II	2

(Note: The table is to be read as follows: During the first period the first variable is applied, and during the second period, the second variable is applied. The table would simply be extended in the case of three or more variables.)

mine the effect upon pulse rate of jumping as compared with running, the group would be assembled when the pulse rate was normal and be given one of these forms of exercise, and the increase noted. Then, at another period, with pulse rate again normal, they would be given the other form of exercise and the increase noted and compared with that from the first form. The procedure for a one-group experiment is shown diagramatically in the Table I. The great weakness of the method is that in most educational activi-

ties the condition does not return to normal after the first period. There is usually a hang-over from the first to the second period which prevents a true comparison. Moreover, in most forms of learning, the progress is at different rates at different portions of the learning curve. For example, if a typewriting class were taught by one method for one semester and by a different method the second semester, with increase in rate of typing used as the measure of efficiency, the first method would almost invariably be found superior, because it is natural for speed to increase more rapidly at first than in the later stages of practice.

10. Parallel-group procedure. One way to overcome the difficulties noted in the case of the one-group procedure is to use two groups of equal ability in every way, applying one variable to one while the other variable is being applied to the other. This places both groups in the same portion of the learning curve, and eliminates any hang-over from one variable to the other. The only serious difficulty lies in being absolutely certain that the two groups are exactly equal, or that the treatment of the two groups is equal in every way except in the two variables being compared. The various procedures in equating the groups are as follows: (1) To equate by chance, as by drawing lots. (2) To equate by intelligence, pairing subjects of equal scores against each other. (3) To equate by achievement tests, pairing students as before. (4) To equate on the basis of the initial test in the traits or abilities being studied. (5) To equate by the accomplishment quotient, or ratio between achievement and ability to achieve. (6) To equate on a multitude of factors by weighting the scores in each and putting all together

into a composite score. It is important that the parallel groups have not only the same average scores but also the same range of distribution of scores. For example, a group of 100 subjects should not be divided by placing the middle fifty in one group and the upper and lower twenty-fives in the parallel groups, even though this procedure would yield the same averages omit for the two groups.

TABLE II

PROCEDURE FOR PARALLEL-GROUP EXPERIMENT

Group	Variable
A	1
B	2

(Note: The table is to be read as follows: Variable 1 would be applied to Group A and variable 2 to Group B. For three or more groups the table would simply be extended.)

11. Rotation procedure. The rotation procedure has most of the advantages and few of the disadvantages of both the one-group and the parallel-group procedures. In fact, it is simply a combination of these two procedures. It may be thought of as two parallel-group experiments in which the variable applied to group A one time is applied to group B the next. By this means each variable is applied to each group, thus eliminating the problem of equality of groups as well as the problem of different rates of progress in different portions of the learning curve. It does not absolutely eliminate the possibility of more hangover from the first period to the second for one variable than for the other, but it reduces the liklihood

of such a thing to a minimum. A wider adoption of this procedure is very much needed. The procedure is summarized in the accompanying table.

TABLE III

PROCEDURE FOR A ROTATION EXPERIMENT

Periods	Variables	
	1	2
I	Group A	Group B
II	Group B	Group A

(Note: The table is to be read as follows: During the first period, variable 1 would be applied to Group A and variable 2 to Group B, etc. For three or more variables the table could be extended.)

12. Experimental discovery of causes. The procedures outlined in the preceding paragraphs are for use in discovering the effects of causal variables which are subject to voluntary control. Frequently, however, we meet a situation in which we have a given result but do not know what cause is responsible for it. For example, if a rattle develops in an automobile, a "causal investigation," to borrow CcCall's term, is needed to discover its source. Whereas the usual type of experiment begins with causes and works toward effects, the causal investigation begins with effects and works back to causes. There are several ways of doing this. One is to list all possible causes and perform a regular experiment on one after another until the one is found which produces the given result, eliminating one cause after another until the true one is discovered. A necessary check upon this procedure is to remove that one cause from the entire original

situation, allowing all the other causes, or variables, to operate unchanged, and see whether the given result is also removed. This embodies the old principle that "Nothing is the cause of a phenomenon in the absence of which it nevertheless occurs." If eliminating the cause eliminates the results and vice versa, the causal relationship between the two is established. Another type of procedure for causal investigations is to frame a hypothetical cause and apply it to all situations possible. If it fits all situations, it has considerable claim to truth, but it is not actually proved until *all* the situations or facts are known, and has to be kept as a tentative cause or theory. This type of procedure is more in the nature of a form of logic than a definite experiment, but has proven quite helpful for the advancement of science. For a clear and detailed treatment of it, the reader should consult the book *Introduction to Reflective Thinking,* Chapter III*

13. Correlation. Sometimes it is quite impossible to arrange a situation where we can secure the complete presence or absence of a variable to be studied, but instead we have to deal with it in varying quantities. For example, we cannot separate children into classes of intelligent and not intelligent and note the effect of intelligence upon school grades, nor can we at will vary the amount of intelligence possessed by a given child and note the corresponding change in school work. We are forced to take the situation as we find it and note whether school work improves as we go from students of low to high intelligence. The device for determining this relationship is the coefficient of correlation. It really amounts to a statistical device for summarizing into one numerical term

*Published by Houghton Mifflin Company, Boston, 1923.

the outcomes of as many one-group experiments as there are individual subjects included in the computation. For the present purpose it is sufficient to say that in order to compute correlation it is necessary to have numerical data about at least two variables for each of several subjects. For example, intelligence scores and mathematics grades for each of thirty children would enable us to compute the correlation between these two variables. This is an outgrowth of the older device of the logicians known as the method of concomitant variation. It is stated by John Stuart Mill as follows: "Whatever phenomenon varies in any manner whenever another phenomenon varies in some particular manner, is either a cause or an effect of that phenomenon or is connected with it through some fact of causation."*

14. Methods of agreement and of difference. There are two types of procedure for the determination of truth which, while not strictly experimental, are sufficiently related to that method to merit brief mention here. They are the "method of agreement" and the "method of difference." These methods are quite thoroughly discussed in the book *Introduction to Reflective Thinking,* previously mentioned. The method of agreement is based on the principle that if two or more occurrances of a given phenomena have only one circumstance in common, that one is the cause of the phenomena. In other words, the method involves finding the thing that is common to all cases where the given phenomenon occurs, and thereby locating the cause of that phenomenon. The method of difference is based on the principle that "nothing is the cause of a phenomenon in whose presence the phenomenon fails

*Quoted in *Introduction to Reflective Thinking,* p. 83.

to occur." In other words, it involves finding the thing that is always absent when the phenomenon fails to take place, and thus determines the cause of the phenomenon. The use of both of these methods combined is naturally preferable to either one alone, since each one is a verification or check on the other. This joint method consists of finding which variable is always present when the phenomenon occurs (agreement) and which is always absent when the phenomenon does not occur (difference.) An illustration of this procedure is involved in Pressey's investigation of the relation between note-taking habits and college grades.* It was found that of ten students who had "full notes well organized" all ten *agreed* in that they were "A" students: It was found, further, that of twenty students who had "unorganized notes," seventeen were "E" students and three "A" students. These two findings combined present rather strong evidence of causal relationship between good notes and good scholarship. This plan of comparing and contrasting extremes has possibilities of application in a wide variety of situations.

15. Hidden variables. Every experiment is in a sense a game of hide-and-seek, in which the experimenter seeks to discover elements in the situation which have not been held constant and which might therefore vitiate the results. For example, in the case of a rotation experiment to determine the relative values of direct and indirect methods in foreign languages, if the teacher who uses the methods has a conscious or unconscious preference for the direct method, this fact may affect the outcome of the experiment. Each

*Pressey, S. L. and others: *Research Adventures in University Teaching.* Public School Publishing Company, Bloomington, Illinois, 1927, page 6.

experiment has its own particular hidden variables of this sort, but a few common ones that tend to come up in many types of studies are as follows: (1) Unequal amounts of time allowed for the two variables to operate. (2) Unequal interest of the subjects during the time the variables are being applied. (3) Unequal vigor or enthusiasm on the part of the teacher or experimenter during the application of the two variables. (4) Unequal skill or ability to apply the two variables on the part of the teacher or experimenter. (5) Unequal opportunity for further progress at the time the two variables are applied. (6) Unequal amounts of preparation for or familiarity with the two variables on the part of the subjects to whom they are applied. (7) Unequal amounts of transfer from one variable to the other form one experimental period to the next. (8) Unequal adaptation of the tests used to the nature of the outcome from the two variables. It should be the ideal of every experimenter to detect any and all such hidden factors as these and to control them, or else to measure or estimate their influence upon the result and thus make appropriate deductions. Simply to point out their existence is a great service, in that it enables later investigators to discover and guard against them.

16. Duplicate experiments.. There are too many weaknesses in experimental procedure on educational problems at the present time to justify putting complete faith in the outcome of a single experiment however careful the experimenter. There is need for doing the same experiment over and over with different subjects, by different experimenters, using different materials, testing in different ways, or carrying the procedure through different periods of time. If several

such experiments yield uniform and consistent results, they justify a much more sweeping and universal generalization. If, however, they sometimes yield results one way and sometimes another, this disagreement helps to define the limits to which the conclusions may apply.

17. Records. If the results of an experiment are to be of service to society, sufficient records should be kept not only to enable later readers to judge the truth of the conclusions but also to enable them to repeat the entire procedure of the experiment in exactly the same fashion. This necessitates keeping complete and detailed records of the study as it progresses. It is better to record an occurrence while it is vividly before the senses than to record it from memory after a period has elapsed. The record should include information about the history of the situation leading up to the experiment as well as the dates, persons, groups, materials, tests, directions, accidents, interruptions, absences, unusual phenomena, etc. etc. In short it should contain anything and everything that might conceivably have any relation to the investigation, since it may develop that the validity of the whole experiment will hinge upon a single one of these apparently insignificant details.

18. Measurement. It is not our intention here to treat measurement in general, since that is done in another place, but rather to point out a few matters of special importance in experimental studies. There are seven of these considerations: (1) Be sure there is a "measurement situation" provided. That is, be sure that due provision is made to check up on what you want to check up. Promiscuous or haphazard administration of tests is costly and ineffectual

unless a plan of campaign is made to be sure the measuring instruments apply to what is to be done. (2) Measure initial status as well as final status. An experiment seeks to determine the *change* produced by different variables, and change cannot be determined unless the status is measured both before and after the application of the variable. A short-cut that is sometimes justifiable is to assume that the initial test would be zero for each variable or else that the two would be equal, and then to treat the final test scores as if they were all change. Needless to say this short cut should be employed with caution. (3) Refine the measuring technique by means of technical instruments of precision wherever they are available and the thing measured is of a sufficiently delicate nature. Otherwise, there may be changes present which cannot be detected "with the naked eye" but which are nevertheless important. (4) Measure results by several different kinds of tests. What is revealed by one type of test may be different from that revealed by another. One test may be of such a nature as to favor one of the variables more than another, and if only one is used, a misleading impression is produced. When using several tests to measure results, it is well to compute the results for each one separately, as if it were a separate experiment, rather than to throw all the tests together into a single composite. The latter plan throws away a great deal of valuable information which can be secured by keeping the tests separate. (5) Be alert for qualitative results as well as quantitative. There are usually a number of non-statistical byproducts of an experiment which it would be folly to ignore. (6) Measure not only the amount of change produced but the

amount of the variable applied to produce that change. (7) Measure results not only at the end of a long-term experiment but also at intermediate points during its progress. If only the long-term measurement is applied, it is not known what the relative positions occupied by the two variables at all times during the experiment were. It is valuable to know not only which won in the end but how the race stood before the final sprint. Furthermore, some fruits of an experiment are better measured directly at the time than weeks or months later when they have become diffused and confused with the results of numerous other variables within or outside of the experiment.

19. Statistical processes. The subject of statistical technique is treated elsewhere, and only a few words are necessary here regarding the statistics of the experiment. In any experiment which involves individual differences (and that includes practically all education experiments) the use of statistics is necessary in treating the results. The essential steps are as follows: (1) Compute the mean, or average, change produced by each variable and subtract these to obtain the average difference. (2) Compute the standard deviation of the changes produced by each variable and from these determine the standard deviation of each mean, in order to know how certain a second performance of the experiment on a different sampling of subjects would be to yield the same results. (3) From the standard deviations of the two means, derive the standard deviation of the difference in order to know its reliability. (4) Compare the difference with the standard deviation of the difference as a test of its significance. In order to have "practical certainty" that one variable is really more effec-

tive than the other, and that the difference is not due to the sampling of subjects used, the difference should be 2.78 times its standard deviation. This procedure is all outlined very completely in McCall's *How to Experiment in Education,* and is also treated more extensively in the chapter on statistical technique.

EXERCISES AND QUESTIONS

1. Why is the experimental method the backbone of science?
2. What is the greatest difficulty in experimental research?
3. What kinds of problems lend themselves best to short-term experiments? What kinds require long-term experiments?
4. Tell how you would compare the worth of oral and written spelling drill by means of a one-group experiment? A parallel-group experiment? A rotation experiment? Which is best suited to this problem? Why?
5. Name as many "hidden variables" as you can that might creep into the experiment just mentioned, and tell how to deal with each.
6. Select an article or research report and examine it critically for weaknesses in the procedure employed. How could these weaknesses be corrected?
7. Formulate plans for a number of experiments in your own field of interest and submit them for criticism to your teacher or classmates.
8. List as many as you can of the essential requisites of a good experimental procedure.

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CHAPTER III

HISTORICAL TECHNIQUE

1. Importance of special training. There is a rather strong tendency for graduate students who have had no special training in statistical or experimental technique to turn to historical thesis subjects with the idea that anybody can do historical research. Such an attitude cannot be too strongly condemned. Historical work has a well formulated procedure or technique all its own, and is not a field for amateurs to enter lightly. The fact that its materials are not quantitative does not mean that its tests for truth are just common sense tests or that its standards for success are mere matters of whim. An untrained person is as likely to fail in historical research as in any other type. Anyone who aspires to write history should make a definite study of the best books on the technique of historical research.

2. Truth versus interest or propaganda. Although all research aims, or should aim, at the truth, the whole truth, and nothing but the truth, the temptation to depart from this standard is especially strong in historical research. The events of the past are surrounded with a halo of emotional reactions, patriotic sentiments, and personal prejudices which are most difficult to overcome. The purpose of history, as it is commonly written, is to shed light upon the present or provide guidance for the future. This purpose causes a strong urge to introduce good moral lessons or socially desirable conclusions from the facts rather than the conclusions which are actually true to the

facts. For example, it is with difficulty that the historian breaks away from the story of Washington and the cherry tree, because it is to dear to our hearts, and has such a splendid (?) moral lesson. Next to the factor of moral influence as an enemy of historical truth is that of interest. By exaggerating or distorting facts the story may be given a much more interesting flavor than that attached to the drab reality. A mass of highly interesting material about early American schools or teachers may be enjoyable fiction but poor history. The writer of fiction has a great advantage over the research worker in regard to interest, and the latter should consistently avoid being drawn into a contest in which interest is the measure of success. A fact may be uninteresting or even of bad moral influence, but, if it is really a fact, the historian has no license to omit or to distort it. His object should always be to present as complete and reliable a picture of past events as is possible, regardless of the moral or social implications.

3. Getting access to sources of data. Before undertaking a historical study, the investigator should consider thoroughly his facilities for securing the needed information. Since the past is already gone, it is impossible for the investigator to observe it. Consequently he must rely upon such remains or documents as have survived, or else upon the memories of persons who observed the events which are to be recorded. Getting a few fragments of the past is not sufficient for adequate historical work. It is necessary to secure enough fragments to establish at least the general outline of the whole, and the quality of the work varies in proportion to the completeness of the sources consulted. Every time a gap in history is left to be

filled in by the imagination from what occurred before and after, the account is materially weakened. The problem may necessitate considerable travel on the part of the investigator, or considerable expenditure of money in order to have rare documents in distant places copied or reproduced by photostat process and sent to him. The true historian, however, will spare no effort or expense to secure an abundance of material to use in making his reconstruction of the past, nor will he lightly undertake a project before considering whether he is able to pay the price required for success in it.

4. Original versus secondary sources. There are two general types of sources from which to write history. The first, and the most valuable, is the original, or primary, source. It is the actual object, remains, record, or document, which has survived from the past. The other type is the secondary source, or account of the past written by someone who had some kind of access to the original source. Secondary sources may, therefore, be classed as hearsay sources, whereas the primary sources are those which are consulted directly. The ordinary textbooks in history or in the history of education are distinctly secondary sources. Some of these, however, give footnote citations of the original documents from which they were written, and thus point the way to primary sources. For an invesigator to attempt to write a history of some event by comparing the accounts of that event as given in ordinary textbooks, however numerous the sources consulted, could hardly be classed as true historical research. This does not mean that secondary sources are worthless in historical research. They may provide an excellent starting point for investigation, and enable the

investigator to begin where some previous worker left off. Also it may be better to use secondary sources of a high grade than primary sources that are very fragmentary and of questionable merit. The chief essentials in using secondary sources are that they should be used with a due consciousness of their limitations, and that the reader should be made aware of the nature of the foundations upon which the account rests. A type of original source which has very high value is the legal document, law, or court record.

5. Lower versus higher criticism. Having located documents or historical sources, the next step is to criticise or evaluate them. This criticism should be of both the "lower" and the "higher" type. (1) Lower criticism refers to the determination of the actual message conveyed by the source used. For example, it may be a paper that has been much worn, and discolored by age so that parts are illegible, necessitating considerable research to restore the missing parts. It may be written in a foreign language, secret code, or garbled English, whose meaning or interpretation is difficult to get. It may have been copied many times, as in the case of the Bible, with slight changes with each copying, making necessary considerable investigation in order to determine what is the true and original version of the document. All these various processes which look toward a determination of the true and correct text of the document, or to a determination of what it actually says, are called lower criticism. (2) Higher criticism refers to determination of the authorship, date, age, purpose, dependability, etc., of the source, as contrasted with its wording or content. It seeks to answer not what was written but who wrote it, when, why, where, with how much prejudice, etc. Such

a question as whether Homer actually composed the Iliad and Odyssey, or whether they were merely evolved by wandering bards, is a question involving the higher criticism. Until the foundation upon which a body of evidence actually rests is known, it is impossible to know how much faith to put in it. Thus higher criticism must be accomplished before the results of the lower criticism are of historical value. Historical research is consequently something of a cycle, involving the use of historical technique to evaluate documents and then the use of those documents to shed light on historical facts. In other words, before we can learn history from a document, we must learn the history of that document.

6. Internal versus external criticism. The higher criticism of a document may be accomplished both from evidence within and without the document itself. (1) Internal criticism means judging the document from within. For example, the style of one portion of a document may be so radically different from that of another that there is no room for doubt that two different persons wrote the document. This type of evidence has proved that some of the plays ascribed to Shakespeare were written in part by other persons. Again something in a document may show a premonition of future events so strongly as to prove that it was written years later than the date given and simply dated back. The language and style may shed considerable light upon the kind of person doing the writing, revealing him as ignorant, educated, prejudiced, careless, critical, bigoted, dishonest, fairminded, etc. The trained historian can learn much about the value of a source by such internal evidence. (2) External criticism seeks to determine the value of a source from

evidences outside. For example, the author of the document may be referred to by his contemporaries as a scholar, an ignoramus, or a knave. His work may be referred to, or his subject treated by another author, thus giving an opportunity to compare the two accounts, or it may quote or be quoted by other documents which shed light upon it. External criticism includes also the checking of statements against the facts of science and against standards of common sense to determine whether the assertions made are possible or probable. To summarize, then, a complete criticism of a document or source involves both lower and higher criticism, from both internal and external evidence; or to put it another way, it involves finding what it tells, and how much credence its message deserves, checking these against evidence within and without the document.

7. **Genuineness versus worth.** There are two main tests that should be applied before using a given source or document. These are genuineness and worth. A forged or altered document is clearly of doubtful worth, whether the alterations were made deliberately to deceive, or simply by carelessness of the copyist or printer. But genuineness does not guarantee worth. A document may be the genuine and original writing of a man whose statements are not dependable. How to judge the worth of a witness's statements may be answered in part by looking for the following points: (1) Who is the witness? If anonymous, his testimony is doubtful. (2) Where did he write it? If he wrote it at the scene of the event, it is of more value than if he wrote it from a distance. (3) When did he write it? If at the time, it is preferable to writing made from memory at a later time. (4) Why did he write it?

If he had some special interest or selfish motive for presenting a certain version, his account would be questionable. (5) What opportunity did he have to observe the events he described? Unless he was in a position to get the facts accurately, his account would be of small value. (6) Was he capable of using his opportunities for gathering the facts? Even though he was in a most favorable situation to observe the thing accurately and well, if he was deaf, blind, careless, or prejudiced, he would be unable to use the opportunities he had. (7) Was he of a sober and accurate turn of mind, or was he imaginative and flighty? (8) Was he absolutely honest, so that he would report the facts according to the best of his ability? (9) Was he an eye witness or did he rely on hearsay for his information? In short, in judging a witness to a past event, it is necessary to apply all the tests that would be applied to a scientist at the present day, and if he is not a good scientist, his testimony is to be treated accordingly.

8. **Note-taking.** Writers on historical research practically all agree upon the importance of having a definite plan of note-taking for the work. Since it is impossible to generalize or to establish the facts about a given event until the evidence is all collected, a note-taking system should be such as will preserve the essentials of each source until they have all been assembled. It should also permit the ready assembling of all statements bearing on a given event in one place, where they can be before the eye at once. Some historians report the practice of writing all statements bearing upon a given event on the same large sheet to keep them all together. Others accomplish the same purpose by means of cards. It is very important that the

notes represent accurately and truthfully the sources from which they are taken. Ordinary quotations are preferable, as they involve less likelihood of distortion. Also quotations are more serviceable as means of giving credit for statements made. Care is necessary, however, to avoid selecting quotations in which the meaning, apart from the context, is different from that which they have in their original settings. Also, extreme care is necessary to avoid changing the meaning of a statement by slight errors or omissions during the copying. A few checkings of copied material will reveal the fact that the ordinary person cannot trust himself to copy anything accurately, and that all notes must be checked back with the original copy from which they come.

9. Establishing facts. Before an event can be established as a fact, there must be evidence for it. Probability and reasonableness do not justify a conclusion without evidence. A fact is said to be established when two or more competent, independent witnesses agree upon it. Stress has already been laid on competence, but independence deserves special mention. Two witnesses may report the same story, yet not be independent. One may have heard it from the other or both from a third person. Also they might both have been deceived by the same circumstances surrounding the event. The courts of law have been obliged to set up very definite limitations regarding the kind of evidence which is acceptable, and many of these limitations are equally applicable to the general field of historical research. When absolutely conclusive evidence is lacking, the historian will simply state his conclusions as possibilities, taking pains to tell upon what kind of evidence they are based. The better the train-

ing he has, the fewer dogmatic and unsupported statements he will make.

10. Composing the narrative. After the facts have been established, the next step is to write them up in a form that will make them available, and serviceable to others. This phase of the work is more an art than a science, but the value of the preceding science is very much dependent upon it. Unless the facts are presented intelligibly, and more or less interestingly, they will be of little worth. As a general rule it is necessary to decide whether the narrative is to be written for the popular reader or for other historians, since the former is interested mainly in the facts and the latter mainly in the evidence. The account may be organized in any one of several different ways, as chronological, topical, biographical, etc., the particular plan depending upon the writer and the subject. But whichever scheme of organization is employed, the best genius of the writer should be devoted to making that scheme compelling and effective. Also the narrative may include the author's own philosophy or interpretation of the events, provided a clear distinction is made between what is fact and what is the author's interpretation of the fact.

11. Documentation. After a number of documents or other sources have once been critically examined and their worth appraised by one careful historian it should be unnecessary for this work to be repeated by others, except for the purpose of checking. This necessitates leaving a careful and complete record of all sources consulted and all evidence which has been used in the establishing of the facts. To arrive at the conclusions laboriously and critically and then put into the records only the results of that labor is most inconsiderate, both of the reader and later historians. The documentation

of a work of history calls for liberal footnotes citing sources of evidence and their peculiar merits, as well as free references to them in the body of the narrative. The merit of a piece of historical writing is to be judged in terms of its freedom from unsupported statements and of the ease with which the reader can check upon statements to see whether the historian has properly evaluated the evidence.

12. Investigating recent or present educational trends. A favorite type of thesis topic for graduate students in education is that illustrated by "Recent trends in the teaching of algebra," or "Present tendencies in the teaching of shorthand." This is a very worth while type of problem, but it is often undertaken by very crude and unsatisfactory procedures. A common plan is to collect from various writers of books and articles a number of statements which give those authors' opinions of the trends and to say those are the trends. Another common error is to find out something about present conditions or practices and not even trouble to find out what were the previous practices that corresponded to these. The following principles and procedures may help to improve practice in this phase of historical research: (1) It takes two points to establish a line. Consequently, a trend is to be measured by comparing conditions or practices at two different periods of time. (2) The further the points are apart the less the danger of making an error in the general direction of the line through imperfect techniques. Thus a study of trends which compared two periods separated by fifty years would be more reliable than one which covered a period of only five years, other things being equal. (3) It is better to contrast two periods that are separated in time than

two that are adjacent in time. For example, it would be better to compare practice in 1890-99 with that in 1920-28 than to compare practice in 1890-1909 with that of 1910-1928. The former is a more sharp contrast than the latter, because it measured extremes within the period in question. (4) Frequently a study of trends requires a combination of historical technique and survey technique, the former to determine what the practice was during the earlier period, the latter the present period. (5) The conditions and practices of each period should be tabulated, or classified, according to the same scheme, else they are not comparable. For example, "number of pupils in high school" in 1890 and in 1920 must take into consideration the junior high school movement. (6) The data for each period should be stated in statistical or numerical form if at all possible, as numbers are likely to allow less room for subjective errors than adjectives and verbal descriptions. (7) For some problems the use of index numbers such as have been devised by the business and economics specialists may be used to advantage. (8) Textbooks of the two contrasted periods may be analyzed and compared as to percentage of space given to different topics as a means of comparing educational practices. This would show the decrease of certain kinds of material and the increase of others. (9) Professional books, that is, books for the teacher instead of the pupil, may be analyzed as to space distribution, or as to the authors' views upon a selected set of issues, and results for the two periods compared to show trends in educational thinking about the particular educational problem. (10) Periodical materials written for teachers may be compared to show shifts of emphasis in views about the educational

problems from one period to the next, and are sometimes preferable to books because they permit a more extensive sampling of authors. (11) The dates of publication of books may be used to show trends by showing the increase or decrease of publications on a given subject as compared with some other field. For example, it is possible to note whether the number of social science texts published has increased faster than the number of Latin or Mathematics texts. (12) The number of articles published in periodicals on a given subject for two periods may be compared to show its increase or decrease in popularity as a subject of discussion in the journals. (13) The number of entries in the Readers' Guide, International Index, or United States Catalog on a given subject may be counted to determine trends as shown by number of publications. For example, if the subject of "art" showed a larger percentage gain in entries in 1925 under "Art Appreciation" than in 1910, as compared with entries under "Painting" or "Design," we should say there was a trend to magnify the importance of appreciation. (14) Old examination question whose answers have been saved may be given to children of the present, and the scores compared to see what change in outcomes of instruction has taken place in the meanwhile. (15) Questionnaire studies that were made years ago may be repeated in identical fashion today and the answers compared. (16) Great care should be taken to see that the materials chosen to represent the two periods to be compared are truly representative of their respective periods. 17) The existence of a trend should not be taken as a justification of it. It is entirely possible that the trend may be in a given direction when the actual scientific facts would justify the opposite course.

13. Historical errors. In closing this brief discussion of historical technique it seems fitting to give a list of typical errors which are commonly made by historical workers and which are especially to be avoided*: They are as follows:

(1) Statement of facts without evidence.
(2) Misstatement of facts.
(3) Wrong interpretation of facts.
(4) False conclusions from the data.
(5) Inaccurate quoting.
(6) Substituting probability for fact.
(7) Argument from silence.
(8) Argument from anology.
(9) Plagiarism.

*Mentioned in lectures given by Dr. M. W. Jernegan, University of Chicago, Department of History.

EXERCISES AND QUESTIONS

1. How does historical research resemble the work of the judge and jury in a trial?
2. What is to be gained and what lost by writing true history and no other kind?
3. How does historical research compare with other types of research as to feasibility in your own particular case? For students of education in general?
4. How does the practical value of historical research in education compare with that of experimental research?
5. What are the principal materials which you could use if you were to undertake a historical problem? Are these adequate?
6. How would you judge whether a source was original or secondary?
7. Is it possible to write a complete history of any past event? Explain.
8. Why are footnotes more needed in historical research reports than in experimental ones?
9. How do studies of present or recent trends compare in value with other kinds of historical research.
10. Collect a few references to historical investigations and read at least one such report, trying to identify each of the steps employed by the person who made the study.
11. Formulate what you consider the essentials of good historical research.

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CHAPTER IV

PSYCHOLOGICAL TECHNIQUE

1. Psychology as a science. Psychology in times past was closely associated with philosophy. Its method was largely that of rational criticism and analysis rather than observation and experiment. Speculation was used to build up elaborate structures of theory which would not bear the test of objective verification. The separation of psychology from philosophy is now recognized as imperative. It is time for the building of "armchair" theories by philosophical methods to give way to strictly scientific ways of studying psychological phenomena. The common notion that one system or school of psychology is as good as another is a result of the fact that for a long time each school of psychologists started with its own major premises and proceeded to speculate, with internal consistency as the principal test of the soundness of the theories, each naturally getting different results from the others. With the perfection of more objective and scientific procedures the day is rapidly approaching when we shall have *one science* of psychology instead of *several systems of philosophy* about things psychological. Some of the principal ways of attacking this field scientifically are given in the following paragraphs.

2. The experiment. The psychologists seem quite agreed that the experimental method is a central one in their science. It has been stated that "experiments are far more reliable than experience" as guides to the understanding of behavior. They involve subjecting the individual to a well-controlled set of conditions, applying a desired stimulus, and noting the resulting behavior. Such a procedure is infinitely better than

trusting the uncontrolled observations of one or more individuals as a basis for conclusion. Since the procedure for an experiment is largely the same in principle in one science as in another, the chapter on experimental technique should be reviewed in relation to the present one.

3. Observation. Some of the early writings on psychology were based on what has been called "the method of anecdote", or the collection of a number of stories, incidents, cases, or experiences of a psychological nature which had come to the various persons reporting them. Thus a collection of anecdotes about behavior of lower animals which indicated unusual reasoning ability might be used as a foundation for a conclusion regarding the intelligence of lower animals. Such methods have proven unsound and misleading. The anecdotes are usually based on unsystematic observation, often by an untrained observer, and without adequate records being made at the time to guarantee accurate memory of the facts. To take its place there has been developed an elaborate technique for careful, continuous, and prolonged observation by highly trained observers. For example, Thorndike studied animals in this direct way in some of his early work, and Watson took opportunity to observe infants in maternity wards and hospitals in a way that would insure much more accurate data than that which mothers could be relied upon to report about their own children. Rather than to collect anecdotes from many observers, it is better to let one observer make many systematic observations of the phenomena in question. This will frequently involve the use of special laboratories, and even the invention of new instruments or apparatus to aid in making the observations. A little

study of the catalogs of companies which manufacture psychological equipment will sometimes go far to suggest available instruments which may be used, or to give ideas for the making of new ones. Further suggestions on the technique of observation are given in a separate chapter.

4. The conditioned reflex. Many forms of behavior are difficult to observe because they are internal rather than external. It frequently happens, also, that language is not available as a means of getting a report on those forms of behavior, as in the case of studies on animals, infants, feebleminded people, or foreigners. The conditioned reflex is a useful device in such situations. For example, if a bell is sounded and a bright light flashed into the eye simultaneously for a number of times and then the bell is sounded alone without the light, it is found that the pupil of the eye contracts just as if the light had been flashed upon it. Similarly, other combinations or associations can be effected. This makes it possible to graft upon an internal, and therefore hidden, form of behavior, some very objective and concrete form of external behavior which may become a signal or an indication that the inner response is taking place. This device substitutes the observation of an explicit or outward response for an implicit or non-muscular one, and makes unnecessary the resort to introspection or verbal report upon the internal reactions. The method is particularly good as a method of studying sensory discrimination, but it has also many other applications. Further treatment of its use may be found in the writings of Watson* and others.

*Particularly Watson, J. B. *Psychology from the Standpoint of a Behaviorist*, pp. 28-38.

5. Neurology and physiology. Some of the most illuminating studies in the field of psychology have been based upon actual dissection of the brains, nervous systems, sense organs, etc., of men or animals. One important part of the task of understanding behavior is to study the mechanism by which that behavior takes place, of which, naturally, the nervous system is an important part. When this method is combined with that of experimentation, it proves quite fruitful for some purposes. For example, local stimulation may be applied to a particular nerve ending and the consequent muscular response noted, or, what is a bit more severe, surgical operations may be made upon animals, removing certain portions of the brain or severing nerve connections and observing the consequent changes in behavior. Of course, it is impossible to study all phases of psychology by the neurological or psysiological methods, but it is also true that it would be impossible to dispense with them.

6. Pathology. The study of abnormal or pathological cases often sheds a great deal of light upon the ordinary or normal cases. An insane person may manifest in an exaggerated degree a trait or form of behavior which is present in less degree in ordinary persons but which has been overlooked; or a person suffering from paralysis may, by his loss of a certain power or ability, call attention to things whose importance has not been fully appreciated before. Just as a man learns more about automobiles when they give trouble than when they run smoothly, so we discover many things about human nature by the study of the decay or disintegration of mental powers that we can never learn by the study of those powers when they are in perfect condition. Abnormal psychology is, therefore, more than a

field. It is a *method.* It is a field in that it represents many urgent problems that are in need of solution for the sake of the persons involved; but it is a method in that we may use these cases as a means of getting at the more general laws of behavior for normal persons as well. Some of the important educational advances of recent years are due to lessons learned in dealing with delinquents, feebleminded children, or school failures, lessons which were equally applicable to all children. A well-known educator has said that some of our best schools are to be found in the institutions which are designed for abnormal or problem children. The psychological clinic, called upon as it is to solve the difficulties of numbers of maladjusted individuals, can give us some of our best information on human nature in general. Similarly, our "study clinics", wherever they exist, may add much to our knowledge of the nature of the learning process and the psychology of particular school subjects and tasks. It is not our intention here to encourage amateurs to undertake investigations involving diagnosis and treatment of abnormal individuals, but rather to encourage more effort on the part of experts already so engaged to generalize their findings and to put their information to use for the benefit of mankind as a whole.

7. The study of animals. There are several factors which make it desirable to study animal behavior as a means of getting psychological insight. (1) There are many problems involved in training and dealing with animals which deserve investigation on their own merits. (2) Since man represents an advanced stage in the evolutionary process, it is profitable to understand that from which man's behavior has sprung. (3) Animal behavior, because it is simpler than that of man, is for

that reason easier to study than man's. (4) The absence of higher thought processes and of self-consciousness on the part of animals makes it easier to get examples of the lower types of responses from them in a state of purity not always possible in man. (5) It is easier to control the life and environment of animals than of men, since they may be imprisoned, starved, mated, etc., at will. (6) More drastic measures may be employed with animals than are permitted with man, even extreme cruelty, permanent disability, surgical mutilation, vivisection, and death. (7) Their shorter life span enables an investigator to study infant, mature, and senile behavior all in the span of a few days or months whereas human beings would require years. One important caution is in order here, that the drawing of inferences from animal to human behavior must be done with the utmost care. What is true of rats or cats may not be true of men or women or boys or girls. The processes by which dogs learn a maze may not be the same as that by which children learn to write. It may be well to perform an experiment first on animals to learn as much as possible from that source, but it will be necessary to repeat it with human subjects as a final check and verification, if conclusions of significance are desired.

8. **Genetic studies.** Several of the advantages of the comparative method, or study of animals, are also present in the genetic method, or the study of children and of primitive man. Children and savages are more naive or unsophisticated, and hence, respond in a simpler way than civilized adults. Since much of psychology is a matter of inborn tendencies, what is more natural than to go back to that period in man's existence when these tendencies were becoming imbedded in human nature,

or when they functioned with a lesser admixture of the learned forms of behavior which characterize civilized life? Or what is more natural than to study human nature as it is manifested in small children, relatively free from the artificialities produced by environment and training? Since it is so difficult to secure for study primitive peoples of the present day who are really typical of those who furnish the genetic background of present civilized peoples, the greater amount of genetic studies now are being devoted to children. There are several points which should be considered by those who make such investigations: (1) Studies should begin at, or in some cases before, birth, in order to be able to distinguish more closely between learned and acquired behavior. (2) The dates and circumstances of the appearance of particular responses for the first time should be fully recorded. (3) The observations should be continuous rather than intermittent, if possible. (4) A few intensive studies ordinarily prove more valuable than several superficial ones. (5) It is better to observe the same children for several years than to make observations of several different age groups at one time, and let these represent the course of development which all children are supposed to follow. (6) Ordinarily the studies are made best by persons who are not related by blood to the children who are studied. Mothers are seldom able to observe and interpret scientifically the behavior of their own children because of their parental feelings and bias. (7) On account of the complexity of behavior after the period of early infancy, it is ordinarily necessary to select for study some single phase of the child's conduct and not attempt to record everything he does. (8) It is often necessary to reverse the order of genetic

studies, going back into the history of an individual child to find the roots of a trouble or behavior disorder from which he is suffering. The mental hygiene expert is often much concerned with the genesis of the trouble from which his patient suffers.

9. Psycho-analysis. In recent years a number of procedures which are based upon the general concept of *the unconscious* have been evolved for studying human nature. The idea is that we have, in a sense, two selves, the conscious and the unconscious, and that there are many powerful impulses or motive forces working in us which we will not admit or recognize as being present. For example, we may suppress our sex desires so that we do not know that we have them, but we go on giving them expression in a disguised way through interest in art, religion, or charity. Or our suppressed desires may gain expression through dreams, day dreams, slips of the tongue, automatisms, etc. A rather wide variety of research procedures have been evolved which rest upon this line of reasoning. For example, dreams, day-dreams, etc., have been recorded and studied as a means of discovering the roots of mental disorders suffered by patients in institutions for the treatment of mental diseases. Likewise, children's daydreams, slips, and careless errors have been studied for light upon personality disorders from which they suffered. Similarly, association tests have been devised to detect lying, and even to secure from a person information which he did not know he had in his possession. The method of psycho-analysis involves simply the observation of behavior which we indulge in when we are "off our guard" as a means of learning what are the dominant impulses that we have failed to recognize as present in us.

10. Introspection. A lively, and sometimes bitter, debate is going on among psychologists as to the recognition that shall be given to introspection as a method of studying psychology. The chief objections to introspection are as follows: (1) That introspection interferes with the state of mind that is being introspected. (2) That introspection assumes the existence of consciousness, whereas one school of psychologists maintain that only behavior is subject to scientific study. (3) That introspection is individual, in that no single person can introspect any mind besides his own, and hence that adequate standards for comparing mental states are lacking. (4) That introspection is impossible as a means of studying infants, animals, or persons who lack language. (5) That introspection breaks down where it is most needed, in the study of complex mental states; the fact that it is so subjective makes it questionable when the processes studied are of an intangible sort. (6) That what a person thinks to be his mental state or his dominant motive is an unreliable index to what it really is; he is quite often self-deceived and unable to make accurate analyses of his own state of mind.

Arguments advanced in favor of introspection are: (1) That to study behavior only and to omit a study of consciousness is to exclude from consideration an important portion of the field of psychology. (2) That introspection is simply self-observation, and in many cases may be as objective as the observation of others. (3) That whereas observation of behavior is only a means of *inferring* the nature of the accompanying conscious states, introspection is a *direct* observation of those conscious states themselves. (4) That introspection is merely a "reflection upon" experience, or

becoming interested in its relation to other experiences, and is not materially different from the formation of judgments about any other kinds of facts. (5) That it need not be merely an individual method, since several persons may observe themselves and report their observations verbally. (6) That the introspection does not banish the mental state introspected, but rather that it simply observes that mental state as it gradually fades out and gives way to the introspected mental state; in other words, that the two processes or mental states linger together in the mind for a time, during which one may be studied by the other. (7) That verbal reports upon the general nature of the behavior may tell more than detailed or minute objective analysis of the behavior itself would tell. (8) That introspection may be useful as a source of suggestions or hypotheses that may be studied by more refined methods. (9) That introspection may yield valuable rough or approximate observations and pave the way for other studies involving more precise methods. (10) That a due appreciation of its limitations would eliminate many of its disadvantages.

11. Testing. Many abilities, mental states, or forms of behavior that cannot be observed directly can be studied very objectively by means of tests. Given sufficient resourcefulness and ingenuity, a test can be constructed to measure almost any psychological phenomenon imaginable—attitudes, instincts, sensory discrimination, self-consciousness, suggestibility, memory, reasoning, and many others. These need not be, though often are, of a verbal or linguistic nature. The service rendered to the science of psychology by the Army Alpha and Army Beta tests is sufficient justification for the favorable reception which psychologists

give to tests as psychological instruments. Some further discussion of the technique of testing may be found in the chapter on measurement technique.

12. Learning curves. Considerable research has been done along the line of keeping detailed records of progress in learning various tasks, as ball-tossing, mirror-drawing, or mastering foreign vocabulary. Yet much remains to be done in this line. Learning curve studies may well be made for other tasks that have not been previously investigated, or for the same tasks under different circumstances as regards motivation, length of practice periods, etc. Until we know in detail all there is to know about the nature of learning for each school subject, exercise, or lesson, there will still be room for careful scientific work of this type. Care should be taken, however, to avoid duplicating studies that have been previously published, and to be sure that the particular example of learning to be investigated has sufficient social utility to warrant the expenditure of effort.

13. Individual differences. Much of the effort of psychologists has been spent in learning the characteristics of human beings in general, but, on the other hand, and particularly in recent years, considerable effort has been spent in learning how individuals differ one from another. Also, special groups have been compared to determine group differences, as between boys and girls, white and colored, city and country residents, etc. In reality the study of individuality and the study of the universal traits of human nature are very closely similar. Statistical method is fundamental to each. By means of it we can bring many individual cases together and discover the central tendency and degree of dispersion, or we may subclassify the cases

and note the uniformities running throughout all cases within a group, and how they differ from other groups. The fact that human behavior is so variable makes one of the fundamental problems of psychology the search for norms and the discovery of the amount of departure of individual cases from these norms.

14. Applied psychology. Much psychological research is needed to coordinate and correlate practice with the theory which we already know. This work may proceed from theory to practice, or from practice to theory. For example, the fundamental generalizations arrived at by the pure psychologists may be tested out in practical situations to determine their specific applications. It is not enough to know the general laws of learning; we must know also something about the laws of learning arithmetic, spelling, or music. The study of such a problem requires a discovery of the nature of the bonds involved in mastery of these respective subjects, and the effectiveness of the various instincts or innate tendencies as motives for the learning. It would be most unfortunate if the results of experiments on ball-tossing or on memorizing nonsense syllables were "transferred" bodily to the learning of handwriting or history. The other angle of approach to applied psychology is that from practice to theory. For example, specific problems in classroom procedure may be attacked by scientific procedures, and when several such problems have been solved the results may justify the inductive formulation of a general psychological principle or law. Likewise, observation of classes at work analyzing textbooks or reading books on educational practice may raise problems of a psychological nature which become food for serious

thought by those who are not primarily educational practitioners.

EXERCISES AND QUESTIONS

1. How does psychology resemble philosophy? How does it differ?
2. In what way does psychology differ from the physical and biological sciences as regards is techniques?
3. Describe a situation in which the conditioned reflex could be used for research purposes.
4. What similarities do you see between the neurological and the pathological approaches to psychology? What differences?
5. Mention some problems of educational significance which might be attached by the study of animals.
6. What relation does the genetic viewpoint have to psychoanalysis?
7. After reading a number of authors' viewpoints on introspection, formulate what you consider a tenable position regarding it.
8. Examine a number of psychological investigations and classify them as to the types of psychological technique used.
9. What is your reaction to the criticism that psychologists are putting too much faith in testing?
10. Ouline the major types of educational problems that seem to call for psychological techniques.
11. How can psychological research be made to contribute more to education?

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CHAPTER V

CASE-STUDY TECHNIQUE

1. Nature and purposes of the case study. As the term implies, the case study has to do with individual persons or situations rather than with large groups or collections of persons or situations. It is a study of individual cases rather than cases in the aggregate. It is more concerned with the individual than with society as a whole. It is interested in discovering what is unique rather than what is characteristic of large numbers of persons or situations. It is more concerned with the exceptional than with the typical. It attempts to discover *everything* that is significant in the life or behavior of an individual person rather than *something* that is significant for all persons. A few of the special educational situations which call for case studies may be mentioned here:

(1) *The failing child.* His failure cannot be understood or remedied except in the light of a careful study of the factors which are responsible for his failure, and these may be different from those which cause failure for other individuals. The director of a study clinic must necessarily be somewhat of a case worker.

(2) *The disciplinary case.* Problems of morality and ethical character have been a most frequent stimulus to the making of case studies. Those who deal with juvenile, as well as adult, offenders have found it absolutely necessary to secure full and complete information about those whose behavior is causing the

problem. Specialists attached to courts and institutions for correction, as well as school officials who deal with numbers of disciplinary cases, have been obliged to evolve special policies and procedures for giving each individual the special consideration demanded by his case.

(3) *Maladjusted personalities.* The mental hygiene specialist is constantly dealing with persons whose emotional behavior is non-typical. One child may be abnormally shy and timid, another unduly aggressive, a third inclined to excessive fears, and a fourth to fits of melancholy which interfere with his happiness and usefulness. These cases all call for sympathetic and scientific study, looking toward corrective treatment, and each child's case must usually be dealt with separately, because few cases are exactly alike.

(4) *Students in need of educational and vocational guidance.* Fitting an education to a child, or adjusting a child to his proper sphere in the vocational world, calls for a thorough and all-round study of that particular child. General principles or universal formulae cannot be applied automatically or in a blanket way to all children alike. Before deciding whether to recommend law, medicine, plumbing, or piano-tuning to a child as an occupation, it is necessary to know what are the traits, characteristics, capacities, and defects of that child which would make for success or failure in these respective callings.

To summarize, the case study arises from *practical needs* rather than from the field of pure science. It is the device by which the practitioner applies the science that is already known to the cases or individuals with which he works. Case studies in medicine are more commonly made by the practicising

physicians than by the scientific investigators, and social case studies are more often made by the actual social workers than by those students and investigators who are primarily interested in advancing the science of sociology. Similarly, case studies in educational work are naturally of more concern to teachers, administrators, school counsellors, mental hygiene specialists, etc., than to scientists working outside of the actual school situation.

2. Selection of cases to be studied. As a general rule, the selection of cases to be studied is not left to the case worker's choice, because the actual field situation forces him to study particular cases whether he will or not. A physician does not choose whom he will treat, but rather his attention is demanded by those who happen to be sick. And yet there are times when not all cases which really need attention can be cared for because of a shortage of workers or other facilities which are required—a condition quite prevalent in education work. In such a situation, it is necessary to begin where the need is greatest, and where the greatest good can be done. The following considerations may be of some help in determining which cases to select for study: (1) Select on the basis of the social worth of the proposed study and treatment. (2) Select on the basis of the amount of advancement to science which will come from the study. (3) Select incipient rather than advanced cases, so that maladjustments may be corrected before they go too far to be cured, and before they do much harm. (4) Sometimes it is best to select the cases which vary most widely from the normal or typical, in order to have available for study a rather large or drastic sampling of the peculiarity or unusual phenomenon.

(5) Select a few cases for very intensive study rather than making a superficial study of a great many cases. It may be better to cure a few people out of a host of wounded on a battlefield than to give temporary and superficial relief from pain to a large number. The value of a case study depends upon intensive more than extensive analysis and observation.

3. **Diagnosis.** Each case study should be a solution of a definite problem. It should not attempt a complete survey of the individual in general but rather a determination of the cause of the specific trouble from which he suffers. Diagnosis is, therefore, a very fundamental purpose in a case study, for nothing constructive can be done until the cause of the trouble is known. Case work is exactly like the work of the physician in this respect. Diagnosis must come before treatment. A search for symptoms, or outward manifestations of the maladjustments, comes first. This includes a careful inventory of the specific peculiarities which are present. Then it is in order to work back from these to the more fundamental roots of the disorder, or to locate the causes which are not so clearly revealed. It is not always easy to distinguish between the fundamental disturbance and some of its results, and this fact should cause an attitude of caution against attempting to remove the symptom without correcting the disease. The art and technique of diagnosis will vary according to the particular case, and some cases will require the services of highly trained medical or psychological experts while others may be within the scope of possibility for the classroom teacher. Sometimes diagnosis is greatly aided by the use of a list of common causes of maladjustment, with the behavior characteristic of each, against

which list the present case may be checked. More often, however, the task of diagnosis constitutes a major problem in reasoning or reflective thinking, and is subject to the laws which psychologists have discovered to hold true for that form of mental effort.

4. Kinds of information which may be required. There are so many different causes that might possibly create a maladjustment in a school child's life that finding *the* cause is not always a simple matter. For that reason, a list of items to consider may often be of service in helping to make the search in an orderly and systematic way. The following facts have often been found to be important elements in shedding light on case studies and are commonly mentioned by writers on case study technique:

(1) *Physical condition.* This includes not only such things as height, weight, age, maturity, etc., but also health, nutrition, bodily functioning, and physical defects.

(2) *Hereditary background.* The roots of a given child's difficulties may often be discovered in his parents or even grandparents. Knowing more about the family tree and the behavior characteristic of the parents may help to understand the child's peculiarities.

(3) *Mental condition.* A thorough investigation of a child's general intelligence, reaction time, sensory discrimination, power of concentration, ability to study, and similar psychological characteristics, may direct attention to significant causes of existing maladjustments.

(4) *Emotional characteristics.* This includes such things as nervousness, mannerisims, automotisms, epilepsy, hysteria, daydreaming, lack of persistence,

precocious sex development, unethical conduct, wanderlust, impulsiveness, shyness, fears, bigotry, hobbies, attitudes, interests, motives—in short, the whole range of emotions attitudes, and instinctive tendencies with their modifications due to experience.

(5) *School record.* This includes his record of promotion or non-promotion, marks earned on standard tests, teacher's estimates, etc., as well as relative achievements in the different subjects, such as art, arithmetic, spelling, reading, etc.

(6) *Past history.* This includes the record of accidents, shocks, disappointments, sickness, discord, unhappiness, jobs held or undertakings engaged in—in fact, a complete history of his experiences up to the present time.

(7) *Present activities.* This includes such things as work done for money, recreation engaged in, pastimes, pursuits competing for his time, as well as any differences observable between behavior at school and elsewhere.

(8) *Home conditions.* This includes the number of parents living, number and age of brothers and sisters, financial status, occupations of parents, moral, social, and educational traits of his parents, living conditions, happiness or unhappiness pervading family relations, etc.

(9) *Social contacts.* Under this head comes the neighborhood or community in which the child lives, the persons with whom he associates, the teachers or other adults with whom he comes into contact, the persons he likes or dislikes, and similar forms of social stimulation or lack of it.

From the above outline, it will be seen that there is nothing in the child's whole range of experience which

may not conceivably have some relation to the problem which he presents. A case study, however, will not merely make an inventory of these things; it will rather examine each of these critically for its relation to the problem in hand. Information about these things is not to be accumulated for its own sake, or as an end in itself, but only as a means of solving the original problem presented by the child.

5. Methods of securing information.. There are many different ways of getting access to needed information for a case study. A few are as follows: (1) Observation of the child as he goes about his work may often be serviceable. Sometimes the only way to discover his difficulty is through such direct observation. (2) Interviewing the child, or having him report his own observations upon his behavior or his difficulties, is often necessary, although he is unable or unwilling in many cases to give an all-around account of his condition. Interviews at different times with long intervals of time between may be compared to check accuracy of statements, as any person interviewed forgets what he told the last time, and, if he is making the story up, the two stories will not agree. (3) Interviewing parents, teachers, or others who have something to do with him will usually add new information. (4) Visiting the home for actual observation of the nature and character of his home life, or to see him in his natural setting, will often recall a side of his character or personality not observable in the school environment. This may also be a good preparation for interviewing the parents for their help in making a diagnosis. (5) Experimental procedures may at times be practicable; that is, conditions may be especially arranged beforehand and

varied at will to provide desired stimulations of the child for the purpose of observing his reactions. (6) At times it may be necessary to put the child into a special institution, such as a hospital, reform school, or institution for mentally abnormal persons, where the observations and analyses of his behavior may be carried out more thoroughly and also be continued over a longer period of time. In such cases it is sometimes possible to get a longitudinal view of the case in addition to various cross-sectional views, following the development of the various phenomena in a way that would be impossible otherwise. (7) Rating scales and score cards of various kinds may be employed in judging subjective but nevertheless important matters. (8) Tests may be administered to determine his intelligence, school achievement, or physical condition, and special tests may be devised for particular things. (9) The various methods of research which have been evolved by the psychologist may be put to service for this purpose in varying degrees. The chapter on psychological technique should be read as an extension and further elaboration of the present topic.

6. Winning confidence and cooperation. Something can be accomplished in studying a child without his knowing that he is being studied. Interviews and observations may be gained without his knowing that there is a purpose behind it all. As a general rule, however, the information secured in such ways is far from complete, and is very much in need of being supplemented by direct contributions from the child or from his relatives. If an attempt to secure information by disguised methods is discovered by the child or his parents, a feeling of suspicion or antag-

onism is produced which bars the way to the information that is desired.

There are many kinds of information which only the child himself can supply, but which he naturally hesitates to supply. There is a much greater hesitancy about discussing mental weaknesses or abnormalities than physical ones, as if they involved a social disgrace. It is even more difficult to get a frank discussion or confession regarding matters of morality or conduct. Matters concerning sex are spoken of very sparingly, if at all, and then only to persons of the same sex or to the physician. Frequently it is necessary to break a crust of suspicion or fear of the law and get this person to give up a secret which alone can solve the problem which his case presents.

Some methods of accomplishing this are as follows: (1) Get the child to see that he is a problem to himself, and then kindly consent to help him solve his problem. (2) As an opening wedge, tell him you want to find out what his capacities and talents are so that you can help him fit himself into the world of vocations and other responsibilities where he can make the greatest success. (3) Assure him that what he says or confesses will in no way be used against him. (4) Keep what he reports in the strictest confidence, so that he will know that his personal characteristics and intimate revelations will not become matters of general knowledge or public record. (5) Appeal to parents and relatives from the standpoint of their parental love for and interest in their children. (6) Even when it is apparent that the information supplied is untruthful or inaccurate, accept it as if it were not suspected, and check up on it from outside sources, rather than attempt to cross examine the person supplying it.

To manifest suspicion or disbelief simply encourages more lying.

7. Records and case histories. There are several viewpoints from which to consider the matter of case records. (1) If schools and other institutions would keep complete, comprehensive, and cumulative records of all significant facts about all children with whom they deal, normal as well as exceptional, the difficulty of getting adequate information when children come to be problem cases would be greatly reduced. Systematic ways of preserving facts about intelligence, physical condition, and school achievement are coming to be more appreciated in recent years than was formerly the case. (2) The investigator who conducts a case study should write the facts down in a reasonably complete and detailed form simply for the increased definiteness and precision of the study which the writing entails. Also the record, after it has been made, aids the investigator to study the case more comprehensively because it directs his attention to all aspects and prevents overlooking significant items. (3) Complete records should be made for the guidance of those who will have to deal with the child at a later date. Teachers, counsellors, research workers, etc., come and go, but the child demands continuity of attention and service. Unless the facts of a case are reduced to record, a new worker cannot pick up the case where the old one left off. Also, a case which was apparently cured or adjusted satisfactorily may suffer a relapse, in which circumstance it is advantageous to have the facts about the former treatment available. (4) Case records are of great service to other workers in diagnosing other cases of a somewhat similar nature. In the early days of medical

practice, the few cases which were written up became the sources of guidance for other physicians, who only had sufficient skill to repeat the treatments which had proven successful. Social workers, court attaches, psychologists, physicians, and teachers could add much to the common body of science by putting their cases on record to build up an extensive body of data about human problems. (5) It has been suggested that case records should preserve the life and color of the real situation instead of containing statistical and factual statements. The style of the novelist would do more toward leaving a clear picture of the case than the catalog-entry style that has been commonly employed.

8. **Treatment.** A case study ordinarily attempts more than simply to *understand* the case; it seeks to *improve* it as well. The ultimate result should be that the case ceases to be a problem. The peculiarity or abnormality which occasioned the investigation should be corrected and the person that was exceptional returned to the normal or typical group. The treatment growing out of the study should bring the individual back into line so that he will no longer be unique or exceptional. Treatment is therefore, a natural and normal part of the case study, just as treating a patient for physical illness is a natural part of the physician's services. This phase of the work becomes a matter of service rather than research, and hence is outside the scope of this book. There are, however, a few suggestions on how to administer treatment which may be mentioned here. (1) Help the child to help himself, rather than assume the entire burden for him. (2) Give him a chance to weigh the consequences of cooperating or not cooperating in the treatment,

and to decide on the desirability of making the struggle. (3) Preserve his self-respect. (4) Keep up his hope. (5) Be severe at times if necessary, but make it clear that the severity is necessary to avoid even more unpleasant consequences that would be certain to result from lack of severity. (6) Modify the diagnosis in the light of the outcome of the treatment, making the treatment serve as a final check or verification of the accuracy of the diagnosis. (7) Do not be offended or feel hurt if the service rendered results only in personal antagonism or ingratitude. It frequently happens that the patient hates the physician who lances a boil for him, and that a professional servant who cures a moral or personal abnormality incurs the hatred of the person served.

9. Generalizing. As was stated previously, the case study is concerned with what is unique or individual rather than with what is typical or universal. It represents a radically different point of view from that of the statistical study which seeks to find the general and universal and ignores the unique or particular. The two methods are, in a sense supplementary. To carry into case work the statistical frame of mind would result in almost certain failure. Case studies, by their intensive nature, must be limited in number, and are therefore unsafe as bases for sweeping generalizations. And even if there were adequate numbers, the cases would not be representative, because they exist only by virtue of their being exceptional. The range of variability of a number of such cases would be so great that any central tendency that might be observed would be only very roughly representative of the cases from which it was derived. Furthermore, any attempt to generalize or to classify cases into

types while investigating them might tend to warp the diagnosis to fit the type rather than to make it fit the individual case.

And yet, in spite of all these negative considerations, there is a certain need for generalizing from case studies. It would be most extraordinary if a number of cases had nothing at all in common, or presented absolutely no similarities. The diagnosis and treatment of a dozen cases should be a good preparation for the diagnosis and treatment of another dozen. The ultimate result of case work should be the collecting of a large body of case records; our knowledge of exceptional cases would thus become so complete that these very exceptional cases would be reduced to general rules and cease to be exceptions. In the early days of medicine, smallpox was an exceptional disease, as were cholera and typhoid, but they are now known as common types because we have studied enough cases to be able to generalize about them. Similarly the educational problems that must now be dealt with as exceptions may finally be dealt with according to regular rules or laws. The point to note here is that the generalizing should not be mixed with the case study itself, but that it should come somewhat as a byproduct after a large number of case studies have been made for reasons of immediate practical necessity.

EXERCISES AND QUESTIONS

1. How does the case study compare with other types of research as regards its contributions to science? To practice? To the professional growth of the research worker?
2. Why is diagnosis a central feature of the case study?
3. What types of case studies seem to be required or needed in the school situation with which you are most familiar? How would you attack these?

4. Why must the case worker be something of a diplomat?
5. What should case records contain? Why?
6. May diagnosis and treatment be separated? Explain.
7. What would be gained and what lost by refusing to generalize from case studies?
8. How would case-studies in educational work differ from those made in medicine? In criminology? In social work?
9. Make a list of the desirable or necessary characteristics of a good case worker.
10. What special cautions should a case worker observe in order to keep his activities on a strictly scientific plane?
11. Draw up an outline of the kinds of case studies which naturally fall in the scope of the classroom teacher. The principal. The school nurse. The attendance department.

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CHAPTER VI

SURVEY TECHNIQUE

General characteristics of a school survey. A school survey is in a sense a case study of a school or of some aspect of it, looking toward a diagnosis of its weaknesses and the setting up of measures for improving them. Or it may also be thought of as simply a research program carried out for the improvement of conditions in a particular situation. A survey is not an aimless collection of facts, nor a collection of facts about all phases of a school system. It may be very specific in nature, covering only a single part of the school's work in a very intensive way. It seeks to solve one or more definite problems. If no problems exist, there is no occasion for a survey. Surveys originate in the actual needs of the schools for practical solutions of practical problems, rather than in the idle curiosity of the surveyors. Occasionally a survey may be of a very general sort, covering practically every aspect of the school's work, but even that type is for a definite purpose, or should be. More often the purpose is more specific, as in the case of a survey to determine whether a new building is needed, or whether a junior high school should be created as a part of the school system, or whether the achievement in the common branches is as high as it should be. Even the general or comprehensive survey will ordinarily consist of a number of smaller parts, each of which, if done alone, would properly be considered a survey in itself.

Since the survey is an attempt to study a definite problem or set of problems in scientific ways, the procedures to be employed are in general those which are applicable to other forms of research. The techniques which are selected must be adjusted to the particular situation and problem. Detailed plans should be made beforehand, and the whole investigation organized with care, in the light of all available knowledge about scientific technique, to be sure that the results help to solve the problems which have occasioned the investigation.

By way of summary of this topic we may say that the survey has three main characteristics; it is purposeful, practical, and confined to a particular situation.

I. Steps Common to All Surveys

Whatever the local situation or the particular problem to be solved, each survey will have many things in common with all others. It is the purpose of this section to treat some of these general considerations which are common to all surveys, leaving to the next section certain more specialized matters.

1. Selling the survey project to the community. Since the making of a survey is something out of the ordinary, and since it usually involves considerable expense, securing the support of the community is a matter of considerable importance. The general public frequently is quite unaware of the existence of the problem which is to be solved, or does not appreciate its importance. In such a case, the Superintendent of Schools and the Board of Education must first be convinced, and then they must educate the community to appreciate the importance of the problem, and then "sell" them the survey as a means of

reaching a sound solution. Experience has suggested several things that may be serviceable in this connection: (1) The amount of financial benefit that would result from the survey may be shown to counterbalance the small expense involved. (2) The importance of securing actual facts as a basis for action may be stressed. (3) The importance of safeguarding the truth by having competent and disinterested experts from the outside collect and interpret the facts may be used as a final and very effective means of influencing a decision. As a general rule, it is well to sell the idea to a few of the leaders, such as the board members and the members of the various service organizations, as a first step, and then to use the support and sponsorship of these persons as an added means of winning a general feeling of cooperation throughout the community. Incidentally, it is necessary not only to sell the idea of the survey but also to sell the idea to a few of the leaders, such as the They must be shown to be competent to carry out the project. After these things have all been accomplished, the matter should be reduced to the status of a definite contract between the school authorities and the survey directors so that the whole may be carried out legally and according to the plans which were agreed upon.

2. Financing the survey. The cost of conducting a survey may be a considerable sum. A few items of expense are the tests used, the tabular forms for recording data, clerical service, special services of the draftsmen, map makers, etc., salaries of assistants, the fees paid to the experts who direct the work, cost of printing the report, etc. Several different methods of financing surveys have been employed: (1) In cer-

tain cases the support of some educational foundation can be secured, especially when the particular survey is such as will shed light upon the problems faced by a large number of other schools. The Russel Sage Foundation, The General Education Board, the Commonwealth Fund, and the United States Bureau of Education have conducted surveys in certain cases at their own expense. (2) There are instances in which surveys have been conducted by the faculty and students of some graduate school of Education simply as laboratory training in the technique of school surveying, and without cost to the schools surveyed. (3) Not infrequently the survey expense is paid as a part of the disbursement for the building program which grows out of the survey. (4) The surveyor is sometimes paid nothing for his services in making the survey, but is employed as an educational expert to supervise the carrying out of the program of remedial work which the survey finds to be needed. (5) Probably the best plan, in most cases, is that of definite appropriation of funds from the school's budget to pay the expense of the survey.

3. Organizing the survey staff. A survey should be directed by one person. He should be in general control over the entire undertaking and be responsible for keeping the entire project unified. The actual work of conducting the survey will, however, ordinarily be divided up into smaller units and be parcelled out among a number of assistants. One committee, for instance, may assemble data upon population growth while another is at work upon the matter of finances, and so on. Each of these committees should be under the direction of a competent and responsible leader who is able to coordinate their efforts and to keep the

work going. These various committees will subdivide their respective tasks into still smaller units, so that each assistant will have personal responsibility for definite things as well as being cooperatively responsible for the group's project of which his forms a part. The assistants who constitute these committees must, of course, be trained in their duties, either as a part of their previous graduate study or by special instruction in preparation for the actual survey, and their work should be checked over and supervised by the director as it goes along. In order to secure greater coordination among the different phases of the work, it is well to build up a social bond among the workers by taking lunch and engaging in recreation together, as well as by more formal meetings for discussion of the progress of the survey and the reports of the various committees. Incidentally, provision for suitable rooms, work tables, calculating devices, and equipment for the actual doing of the work, is important both for its effect on the quality of the work and also for its aid in building a group consciousness among those who work together in the same place.

4. Gaining local cooperation. Even though a survey is being conducted by outside experts, it can hardly succeed without the cooperation of the local school authorities, teaching staff, and community. Many essential facts are available only through such cooperation, and any obstructive tendency on the part of the local people is certain to handicap the work. For example, if the Superintendent and board attempt to put a survey program into effect without consulting the teachers, the latter are likely to feel that they are being investigated. Such a feeling may arouse suspicion, prejudice, or even open hostility. The matter

of keeping everybody happy about the survey is of the greatest importance. Care must be exercised to avoid creating the impression that some one is going to be "shown up" or that the surveyors are engaged in a work of espionage.

Not only is local cooperation valuable in removing barriers, but also as a means of getting assistance in the actual prosecution of the survey. Assistance given by teachers and administrative staff, instead of by imported assistants and clerical workers, not only reduces the cost of the survey but also raises the level of professional spirit and understanding on the part of those who give such assistance. Also the suggestions and criticisms of the school system which are given by the members of its staff may be very fruitful sources of information and of possible needs that are to be met.

5. Securing needed information. The sources of data to be used in a survey will vary according to the specific problem to be solved, but a few general suggestions may be helpful: (1) Actual observation and visitation are essential; to attempt to conduct a long-distance survey is almost certain to result in missing many important essentials. (2) Legal or official documents and records are generally to be preferred. These include the state constitution and statutes, the various county and city ordinances, the records of the county superintendent, the city or county treasurer, the tax assessor, city engineer, and similar officials. (3) The permanent records and minutes of the school board are of considerable importance as authentic sources of information about school regulations, policies, and precedents, as well as of the historical background of the current situation. (4) The regular

school records and accounts which have been kept for previous years are an invaluable source of data for the surveyor. These will, if properly kept, tell much about teachers, pupils, finances, and similar matters. Often they can be made to yield valuable by-product information beyond that for which they were originally intended. (5) The official reports of the Superintendent of Schools may be used in many cases to get in nicely tabulated form what would require much labor to assemble in the first place. (6) Samples of all printed matter, textbooks, special bulletins, courses of study, mimeographed announcements, blank forms, and in some cases the actual files of correspondence, may be utilized to get information about the educational program and matters of internal administration. (7) Special methods must frequently be devised to secure needed informtaion, including testing programs, questionnaires, interviews, and similar research technique.

6. Comparing with other schools. Comparison is a central feature of most school surveys. This is due to the fact that for many administrative procedures and problems there is a lack of absolute standards, thus leaving the practice of other schools as the principal criterion by which to judge an individual school. For example, if the particular school being studied has a much lower valuation of school buildings per capita of students than is the case for a large number of other cities of the same class, this is a strong indication, although not actual proof, that its building facilities are inadequate. Similar comparisons may be made on the basis of size of classes, teachers' salaries, teacher-student ratio, percentage of daily attendance, scores on standard tests, organization of the admin-

istrative staff, etc. The data necessary for such comparisons can be secured, in many cases, from official sources, in other cases from the reports of previous surveys, and in still others from published norms for the state or nation in connection with tests. There are a few suggestions which experience has shown to be important in connection with comparative studies: (1) It is necessary to be very certain that items compared are really comparable. For example, different methods of accounting may cause two cities which are really equal in a given thing to appear quite unequal. (2) Before comparisons are made, the data should be reduced to statistical form. Comparisons made in terms of adjectives are much less helpful than those expressed in numbers or scores. (3) When the items to be compared are relative to other items, as costs are relative to population, such ratios should be computed and used as a basis for comparison as will show up the essential facts without confusion with other elements in the situation. (4) The manner in which data are collected may greatly help or hinder the making of comparisons. If due consideration is made of the form in which data from other cities exist, those from the local school system may be assembled in a manner that is uniform with the others, and thus greatly reduce the labor of drawing comparisons. (5) If schools would develop more uniform systems of keeping records, such comparisons would be easier to make.

7. Forming judgments and making recommendations. The school surveyor is more than a manipulator of facts and statistics. He serves somewhat in the capacity of an expert adviser as well. He must supplement his figures in many ways by common sense

and expert judgment. He must not only find facts but interpret them. He must not only discover how efficient the schools are but make constructive proposals for their improvement. Once the actual facts have been secured and agreed upon, the remaining portion of the task is one of exercising judgment and discrimination to determine their practical significance. The recommendations or proposals that result should be clearly based upon the evidence, rather than drawn from personal opinion or propaganda. Two methods of increasing the reliability and soundness of expert judgments in school surveys may be mentioned here: (1) The use of rating scales, score cards, or check lists is serviceable, since it helps the mind to consider the situation in smaller units and in greater completeness of detail than would be possible otherwise. A building score card is an illustration of this. (2) Group discussion of matters requiring judgment may help to carry the process of weighing and judging various elements further than one person's individual analysis would go. For this reason it would be well for the various members of a survey staff to meet at intervals for reports and conferences, and also for the final report to be submitted to a group of intelligent and interested persons, such as the school board, for final criticism before it is printed.

8. **Reporting the results.** The results of a survey should ordinarily be published, not only for the sake of gaining public support and cooperation in putting the recommendations into effect, but also as an added incentive to careful and thorough work in making the survey. The report should be written for the intelligent layman rather than for the surveyor's expert colleagues, and for that reason should be copiously

supplied with graphical representations of the facts which it contains. It should contain, either at the beginning or the end, a brief list of recommendations, stated in condensed form for ready reference, in order to provide something tangible for study and discussion by persons who could not or would not take the time to find those recommendations if they were buried in the body of the report.

The publication of the report is closely associated with the campaign for bringing its results to the attention of the community and securing action upon the recommendations made. The persons making the survey are not necessarily obliged to direct the publicity campaign, but they are naturally expected to cooperate in it. The first step in this might well be the establishment of relations with the local press before the survey begins. Then news items may be published as the survey progresses, as the judgment of those in charge directs. There is, however, grave danger that such news items may appear prematurely and do more harm than good. Some writers on this subject prefer to hold all information until the survey is completed and open a regular campaign, others to keep the campaign going on the installment plan. There is general agreement that, so far as press notices are concerned, several articles, each on a separate idea, are preferable to a few comprehensive articles. Another phase of the publicity campaign is that involved in making oral reports in person before the school board, service clubs, and other civic organizations. For this purpose, it is often well to prepare large charts, maps, and even lantern slides, which may be used to appeal in a visual way.

II. Technique for Special Types of Surveys

In the previous section of this chapter, we have considered certain general aspects of school surveys which are much the same for all types of surveys. It now remains to outline briefly a few of the outstanding features of some of the more common special kinds of surveys. As was stated before, a survey may be made in connection with almost any phase of school work, however large or small, but the present chapter will be limited to procedures involved in surveys of population, buildings, finance, administrative organization, teachers, pupils, curriculum, and educational results. Further reading on each of these types may be done by consulting actual school surveys and more extensive works on survey technique. It should be made clear at this point that the various special types of surveys to be discussed here are closely related to each other, and that there is often much to be gained by conducting several types of surveys at the same time and in correlation with each other. For example, the surveys of finances and buildings have much to do with administration, curriculum, and teaching efficiency.

1. Population. Surveys of the population of the community are sometimes of considerable importance in solving school problems. For example, the city may be drifting in a given direction, and a section which was formerly inhabited by native whites may be gradually becoming a foreign or colored settlement, calling for a different type of educational program. To discover the sociological or racial character of the population, and the directions of sociological changes, may call for the making of spot maps with a different color of spot for each home of a given nationality or

social status, or a spot for each transfer of pupils to or from the district, one color showing a gain in native whites, another color a gain in foreign-born, etc.

Another population problem is the determination of the direction in which the city is moving, particularly for the light it may shed on the locating of new buildings. The building permits for a period of years may be tabulated or located on a spot map to show up such trends, as may also records of the new installations of light, water, or gas meters or telephones, or the percentage of the total city votes cast by the different precincts.

Again, the problem may be one of rate of growth, in addition to its direction, in which case the records of the various public utilities, the average daily attendance in school, the vital statistics showing birth and deaths, etc., may be used to supplement the data to be obtained from the United States Census. In making such studies these various indices of population growth should be used to check against each other and care should be exercised to avoid relying upon a very few or upon unstable indices.

In more settled and static communities, where the direction and rate of growth may be of lesser importance, and the character of the population may be very little subject to change, the main problem is one of determining the present location of the pupils' homes with reference to the schools. For such purposes, the simple device of placing one spot on a map to locate the residence of each pupil may aid greatly in analyzing the distribution of the pupils with respect to distance from schools, relations to rivers, hills, railroad tracks and similar factors.

2. Buildings. There are several items that may

enter into a building survey, a few of which will be mentioned here.

(1) *Rating the present buildings.* This may involve a careful study of the present buildings, checking them against existing state building codes to determine whether they meet legal specifications for school buildings. More important than this, however, is the scoring of the buildings as to their suitability to the needs of the schools in the more professional sense. For this purpose, the Strayer-Englehardt score cards for school buildings might be used, or the buildings might be checked against any other commonly accepted and well recognized standards that are available as a means of measuring their suitability for school purposes.

(2) *Determining present utilization of buildings.* Not uncommonly a school administrator thinks he needs new buildings when in reality he has ample space for his needs but is not getting the use out of it. To determine the degree to which a building is being utilized, the number of classrooms vacant at each separate period in the day may be determined as a first step. Next might come a study of class size to determine what economies could be effected by putting small classes in small rooms and reducing the number of vacant seats. Or the total number of vacant period seats may be compared with the total peak enrollment, to determine the maximum economies which could possibly be effected, or the total number of pupils that could possibly be accommodated by the present buildings. Needless to say, it would be impossible to secure absolutely 100% seat utilization at all times.

(3) *Determining the amount of new buildings to be provided.* The principal steps in determining how much

new building space is needed are: (1) Finding out how completely the present buildings are filled or utilized, and (2) finding the rate of growth of the school population. Having these facts, it is simply a matter of subtracting the present capacity from the number of pupils to be provided for.

(4) *Locating new buildings.* Finding where to locate a proposed new building is a matter primarily of population study, which has already been discussed. A few additional factors enter, however, such as an analysis of the geography of the region, particularly as concerns natural barriers, traffic risks, and health menaces. The economic phase of this problem also becomes one of major importance at times, involving rather extensive investigations of land values in the various proposed locations.

(5) *Determining the character of new buildings.* Each new building should be constructed with a definite purpose to house a definite educational project or to provide for a particular type of educational program. The kind of curriculum to be offered must be considered in building the various shops, laboratories, etc., and may require a survey of the social needs of the community. This point will be discussed in a later paragraph.

(6) *Determining the ability of the community to provide the new buildings.* Since new buildings are one of the very large items of school expense, no building survey can be entirely inseparable from a financial survey. This will be treated in a later paragraph.

3. Finances. Any complete investigation of the financial side of a school system must necessarily become a task of considerable magnitude. Some of the elements that would enter into such a study are as follows:

(1) *The legal basis of the school funds.* This includes a study of the laws, constitutional provisions, city ordinances, court rulings, etc., governing the raising and handling of school money, and the relative importance of the different sources from which the funds are secured. This is closely related to the topic of administrative organization, and will not be treated further here.

(2) *Community wealth.* This involves analysis of data bearing upon property valuation, ratios between true and assessed value, amount of community income, amount of funds raised for all purposes by taxation, amount of increase in number and volume of savings accounts, wealth per capita, and so on. Such data are useful to shed light on the community's capacity to support schools and are basic to many other questions.

(3) *Percentage of public funds devoted to schools.*. A city may be very rich and able to support its schools, but actually be spending a very small proportion of its money for education. The surveyor might compare the distribution of the tax dollar in the local case with that of other cities, as a means of discovering how well the schools are being supported as compared with fire, water, park, police, and street paving departments.

(4) *Distribution of school costs.* Next after a analysis of the tax dollar might well come a study of the school dollar. This would involve a comparison of the percentage of all school funds going to new buildings, to interest on bonded indebtedness, to salaries of administrative and teaching staff, to fuel, to supplies, etc. Such studies, if compared with similar ones from other cities having uniform systems of accounting, are likely to reveal any significant departures from standard practice in the distribution of expenditures and to sug-

gest desirable changes. Such comparisons may be made more objective if based on such items as cost per classroom, cost per cubic foot, cost per pupil class period, cost per teacher, cost per student in average daily attendance, etc.

(5) *Present balance sheet.* This would involve something of an analysis of all indebtedness, current deficits, surpluses, etc.—in short, a careful summary of present condition as regards finances.

(6) *Business management.* This would include the organization of the staff that has to do with expenditures, the method of determining what money is to be spent, the system of accounting employed, the making and operation of the budget, and all similar things having to do with the method of handling the funds.

4. Organization and administration. A survey of the organization and administration of a school system may involve several different lines of investigation, such as the following:

(1) *Legal background.* This includes a study of the state and local school laws and regulations, and the checking up on such matters as the jurisdictions of the various legally established authorities which touch upon the schools. For example, the discovery of the exact relations of the schools to the County Superintendent and the State Superintendent is essential to the best understanding of their organization and administration, as is also a knowledge of the methods by which school authorities are selected and to whom they owe allegiance. The school surveyor, working on the administrative system, will naturally need, therefore, to be a student of school law.

(2) *The general type of school organization.* Some schools are organized on the basis of elementary, junior high

schools, and senior high schools; others have only elementary and senior high schools. Some communities have all elementary schools under one head while the high schools are under different control. The particular scheme of organization employed in the local situation must necessarily be included as a part of the survey.

(3) *Composition of the school staff.* The survey will ordinarily include an inventory of the various members of the staff, and comparisons of its composition with that of other cities of a similar type. Such comparisons might include such items as the ratio of number of non-teaching members to teaching members, number of supervisor to the number of teachers, etc.

(4) *Job analyses of the various members of the staff.* Sometimes the problem of the survey is to redistribute the various administrative duties among the different members of the staff. The job analysis method is particularly appropriate in this connection. It involves a more or less minute listing of the different activities or duties of each worker, as described more fully in the chapter on job analysis technique.

(5) *Organization charts.* The steps previously mentioned will ordinarily lead toward the making of an organization chart. This is a graphic picture of the administrative staff, with a square to represent each member and lines joining these various squares to show lines of authority and of responsibility. If these charts are carefully made and truly represent the functions that are being performed by the persons whose work is charted, they become very effective means of discovering needed changes.

(6) *Relations of existing status to principles of school administration.* When the facts about the actual adminis-

trative situation have been discovered, it should not be very difficult to check them against sound principles of school administration to determine wherein the practices are unsatisfactory. For example, such a check might reveal that a certain school has a dual control, with a business manager and a superintendent of schools on equal footing, each independent of the other and responsible directly to the board, an arrangement which violates the principle that there should be unified control under the superintendent.

5. Teachers. A survey of the teaching staff might undertake to discover several different things, among which the following are representative:

(1) *The sources from which the teachers come.* This would include such factors as percentage of home-town teachers contrasted with new blood from outside, as well as the sociological character of the homes from which the teachers are drawn.

(2) *The machinery for electing teachers.* This might involve an analysis of the methods used to discover good teachers. The standards used in selecting the best from a number of applicants, the qualifications of the persons making the selections, and all other factors which shed any light upon the extent to which the methods employed are conducive to the securing of an efficient corps of teachers.

(3) *Tenure.* Studies of tenure might involve data upon the average length of service of the teachers, the annual rate of turnover, and the factors which affect these. A low turnover might be due to unusually high salary scales, or to the fact that the teachers are of a lower grade and contented to remain because they are not disturbed by efforts to secure professional growth.

(4) *Character and composition.* Under this head would come such questions as the percentage of women teachers, the nature and amount of academic and professional training, the amount and character of teaching experience, age, race, etc.

(5) *Salaries.* Frequency tables showing the range and distribution of salaries, classified according to amount of training and experience and also according to nature of the teaching positions held, should shed considerable light upon the teacher situation, especially if such distributions are compared with similar ones from other cities.

(6) *Teaching loads.* Studies of teaching load not only include the number of hours of teaching per week, but also the character of the service rendered. They should also include investigations of the relation between subjects taught and the kind of previous preparation which was made for teaching, as well as the amount and character of extra-curricular and administrative duties that are performed in addition to teaching.

(7) *Efficiency of instruction.* The quality of service rendered by the teachers may be studied from either of two angles, process or result. Actual visits to the classrooms may reveal much about teaching efficiency, as may also results of tests which are given to the pupils. This point will be treated in a later paragraph.

6. Pupils' progress. A very common and very important part of any complete school survey has to do with the progress of pupils through the grades. The several ways in which this may be analyzed are illustrated by the following:

(1) *Elimination.* Some idea of the number of students who are eliminated year by year may be gained by comparing the total enrollments for different grades.

These studies usually show a marked decrease of students in school after the sixth or seventh year. Care should be exercised, however, to avoid attributing the effects of retardation to elimination.

(2) *Retardation and acceleration.* Data upon the number of students who are repeating grades, or who for other reasons are below the grades normal for their ages may shed considerable light upon the effectiveness of the schools. It may indicate that too rigid a standard of work is being maintained, or that the instruction is inefficient, or any one of several other things. Analyses of the data on acceleration would naturally extend and supplement studies of retardation. Age-grade tables are very useful for these types of studies.

(3) *Classification.* The effectiveness with which children are grouped into classes for instruction may be determined in some measure by consulting the records to discover the extent of homogeneity within classes. It may be found, for example, that students are being forced to work together who are not homogeneous on *any* basis, or that in the effort to secure homogeneity as to scholastic achievement pupils of widely different ages, sizes, and intelligence quotients have been grouped together. The simple device of making a group photograph for each grade or class may help to show up in a visual way the extent to which there is homogeneity as to size and physical maturity.

7. Curriculum. Surveys of the curriculum may involve some of the research techniques and principles which have been treated in the chapter on curriculum-making technique. In addition to these, there are certain other considerations which may be mentioned here:

(1) The population survey may shed considerable

light upon the kind of curriculum that is demanded for the particular community. This may take the form of an occupational or vocational survey of the community, listing the different kinds of occupations and the annual supply of new workers required in each. Such studies constituted an important part of the well-known survey of the Cleveland public schools.

(2) The nature of the present offering may be discovered by a critical examination and tabulation of the content of textbooks, printed courses of study, or representative samplings of the written work done by pupils in the different classes.

(3) The costs of the various subjects in the curriculum can be determined by comparing such items as teachers' salaries, teaching loads, class size, building space used, equipment required, etc., resulting in definite figures indicating cost per pupil class hour in the different subjects. Such studies have revealed great discrepancies between the costs of different subjects or the same subject in different schools, and have led to worth-while improvements in the nature of the curriculum offerings.

8. Educational results. It has been said that "the proof of the pudding is in the eating." Likewise, the efficiency of a school system must be determined ultimately in the light of results secured. Measurement, or testing, naturally constitutes the principal device for determining the results. The complete school survey will ordinarily include a testing program. For this purpose standardized tests are necessary in order that the results achieved in the local situation may be compared with established norms from other schools or cities. In conducting such a testing program the labor of testing every child in every grade may be so great

as to make the task impossible. A sampling procedure is the device to remedy this difficulty. As a general rule, two types of samplings should be made. One sampling might consist of a measurement of every child in every subject in a given grade, thus getting a complete picture of the sixth grade, for example. The other sampling might consist of measurements of a certain subject, such as arithmetic, in every grade. Thus a horizontal sampling supplemented by a vertical sampling, might tell more about results of instruction than two or more samplings of one type only. Further discussion of this aspect of surveys may be obtained by referring to the chapter on measurement technique.

EXERCISES AND QUESTIONS

1. How does the educational survey resemble and how does it differ from the social survey? The industrial survey? The engineering survey?
2. What part has the school survey played in the development of educational science? How does its service in this respect compare with the contributions made by other research techniques?
3. What are the essential qualifications of one who would make a school survey? Justify each item.
4. To what extent is it legitimate for a survey to be propaganda?
5. How should a survey report differ from other research reports? How resemble them?
6. What is to be gained by making a comprehensive or complete school survey as compared with a special-type or limited-scope survey? What is lost?
7. List the problems in the school system with which you are most familiar which seem to call for a school survey. How would you go about attacking each?
8. Referring to the special types of surveys mentioned in this chapter, show what each type might contribute to the others, or how it might be correlated with them.

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The reading of actual survey reports is one of the best ways to get acquainted with survey technique.

CHAPTER VII

CURRICULUM MAKING TECHNIQUE

1. Practical versus scientific curriculum making. There are two types of curriculum work under way at the present time, both of which are entirely justifiable and worthy. One is the scientific, or strictly research type, looking toward getting actual facts about what should be taught. It seldom attempts more than one small and specific problem at a time and attempts to do that one thing in a thorough and conclusive way. The other type is the practical type involved in course-of-study making. It is prompted by the immediate necessity of doing something *now* and can not wait for the slow and laborious work of the scientist. It involves the application of common sense and the judgments of competent persons in selecting and arranging materials for instructional purposes tentatively, with the idea that it is better to have what experts *think* is a good curriculum than to have what has already proven by experience to be unsatisfactory. This is entirely sound reasoning. It is better to have an empirical foundation for educational practice than no foundation at all, and, lacking a strictly scientific foundation, an empirical one based on common sense and the observations of educational specialists is about as good as we can have. Without at all belittling this practical type of curriculum-making, it is our purpose in this chapter to treat the methods and techniques for the other, or more strictly scientific, type of work. The practical type of curriculum-making is quite commonly done by regular classroom teachers and school officials, and ordinarily begins with the classroom situation. The scientific

type is more often done by research workers or experts somewhat further removed from the actual firing line, and with the use of somewhat more specialized research techniques. It is hoped that more extensive training in such techniques may accelerate this very important type of scientific work.

2. Importance of fundamental principles. An important first step in doing scientific work on the curriculum is to master the fundamental philosophy of education. Briggs has expressed this point by the statement that, unless we get down to the underlying principles, our work will be of a superficial sort, or "curriculum-tinkering" rather than curriculum-making.*

The basal assumptions upon which the work is founded must be sound or the work is not valid. The curriculum maker must be a wise and sensitive interpreter of the spirit of the age, being a close student both of society and of education. He must not put too much faith in purely mechanical techniques. It is possible to analyze the human body into its chemical constituents, but the element of *life* in it is not so readily subject to analysis. Likewise the curriculum-maker may analyze society or human activities in an objective way and still go wide of the mark in the resulting curriculum because of failing to consider the purpose or spirit that moves through it all. To be more concrete, the research worker should at least spend considerable time in reading books on the curriculum by such men as Charters, Bobbitt, Snedden, Bonser, Meriam, Clement, Briggs, etc.

3. Activity analysis. Probably the most fundamental technique in curriculum research is the activity analy-

*Briggs, Thomas H., "Curriculum Problems," The Macmillan Co., New York, 1926, Chapter I.

sis, sometimes called job analysis. It is based on the sociological principle that education should prepare for the activities in which people engage. Having discovered what are the various kinds or types of human action, discovery of the kinds of training needed follows quite naturally. The advantage of this procedure is that it is less influenced by personal opinion. A curriculum based on an analysis of desirable human *traits* or *qualities* involves considerable exercise of personal judgment in bridging the gap between the traits to be developed and the kind of training required to develop them. A good illustration of an activity analysis used for curriculum research is Lehman's study of "Play Activities of Persons of Different Ages."* He determined in considerable detail what activities people engage in "just for fun," and was able to derive from his analysis a number of very significant conclusions bearing on the curriculum.

4. Difficulty analysis. A special form of the activity analysis is that which considers only those activities which are performed imperfectly, or which offer difficulty. Analysis of errors is often less laborious than analysis of activities, and is often a better guide in curriculum-making, because it is not necessary to teach the things which are already done correctly. The difficulty analysis, therefore, consists of finding where practice breaks down or falls short, and discovering from these deficiencies the kinds of training needed to correct them. A difficulty analysis is often useful as a means of completing an activity analysis, and vice versa, since what is overlooked under one classification is likely to show up more visibly under the other. A

*In Bobbitt's "Curriculum Investigations," University of Chicago Press, 1926, Chapter XIV.

good illustration of a difficulty analysis is the study of grammatical errors of children in Kansas City made by Charters and Miller,** in which all mistakes in English were recorded and classified as a basis for determining the kind of grammatical training required by children.

5. Securing objectivity. In making an activity analysis or a difficulty analysis it is preferable to do it in an objective way rather than to rely on personal estimates, generalizations, or opinions. Bobbitt's work at Los Angeles has been criticized because of its somewhat subjective nature. He had many people *think* of all the objectives they could under such heads as health, mental efficiency, etc., and then made a complete list of all these items. These were naturally given from memory and in the lump rather than from direct observation of actual human activity. If each person's contributions had been based on analysis of a particular person rather than "people-in-general", the composite would have been a result of analysis rather than one of analysis and generalization mixed in unknown proportions. It should be said, in justification of Bobbitt's procedure, that it was of the practical rather than the strictly scientific type of curriculum making, and was the only one feasible under the circumstances. Methods of securing objectivity in the analysis are not readily available, especially in analyzing mental rather than physical activities. Yet the need of objectivity is great, and the careful worker will do his best to invent special tools or instruments of precision for the purpose. A few illustrations of such devices may be mentioned here. (1) Frequency of error, for example, in spelling. (2) Keeping of diaries by the individuals whose activities are being analyzed. (3) The case

**Charters, W. W., "Curriculum Construction," The Macmillan Co., New York, 1923, Chapter XVII.

method, as used by the sociologist and clinical psychologist.

6. Dividing the field. With the facilities available at present it is practically useless to attack the curriculum problem as a whole in a single investigation. It is too large to be handled as a unit. Such an investigation involves a complete and comprehensive analysis of the activities or difficulties of millions of people in thousands of life situations, and consequently, needs to be divided up into smaller units worked on separately. For example, one certain occupational pursuit may be analyzed as a basis for vocational training in that one line, or all spelling activities may be analyzed, without considering language activities or mathematical behavior. The great essential in doing this is, however, that the part must not be mistaken for the whole, and that the results of a fragmentary analysis must not be offered as a solution of the curriculum problem in general. For example, an analysis of occupational activities must not lead to the omission of training for leisure, or non-vocational activities, nor should the occupational activities be overlooked because the basis of analysis happened to be academic in nature. Some illustrations of investigations dealing with special phases of the curriculum problem are found in Bobbit's *Curriculum Investigations* and in Charters' *Curriculum Construction,* and include studies of such units as labor problems, etiquette, mathematics, citizenship, pattern making, etc.

7. Short cuts. The task of making an analysis of activities directly is sometimes so great as to be practically impossible. In such cases it is necessary to abbreviate it by some kind of lavor-saving device. The method of *sampling* is one such device. This involves

selecting some situation or field of human activity that is known to be fairly representative of society in general and making an analysis of it, considering the results as equivalent to what a more extended analysis of the whole would have produced. This is entirely justified, provided the sampling is of adequate size and is known to be representative. Some examples of this procedure are given in Bobbitt's *Curriculum Investigations,* where analyses of "major fields of human concern" were based on such samplings as the *Encyclopedia Britannica,* the *Literary Digest,* the *Reader's Guide,* newspapers, the Sears Roebuck Catalog, the dictionary, political party platforms, etc. Any such short cut is only as valid, of course, as its underlying assumption; namely, that the sampling used is a true representation of human life.

8. **Limits of analysis.** A curriculum study may err either on the side of too much or too little analysis. The usual error is on the side of too little. It has not been uncommon for an educational philosopher to analyze life activities into four or five divisions and proceed to build a curriculum upon those divisions. Obviously such a procedure is questionable because the units are too large to be grouped adequately. A much safer and more dependable basis would be an analysis of life activities into 10,000 or 20,000 smaller units which could be classified and grouped into a number of larger divisions. The labor involved in this task explains why most curriculum work suffers from insufficient rather than too much analysis, but it is a part of the price of curriculum progress. Charters says that the perfect curriculum is one that is analyzed down to the point that it is self-teaching. If it is in text-book form it needs no further supplementing or explaining

by the teacher. He says that "neatness", "initiative", and "ability to think" are too large units, and should be subdivided into such specific elements as "brushing your coat" and "combing your hair." In other words, he would carry the analysis to that point which most nearly conforms to the "mental stride" of the learner, taking pains not to present material in units too large to be comprehended, nor too small to yield interest or perspective.

9. Progress. In making an analysis for the curriculum it is necessary to choose the *best* or *most successful* rather than the *average* as a basis upon which to work. For example, a teacher-training curriculum should train persons to teach according to the practice of good teachers rather than that of ordinary teachers. If the curriculum is derived from the practices of the highest stratum of society, the result is the raising of the entire next generation to that level. This is society's method of raising itself "by its own bootstraps." The curriculum should educate for life as it ought to be lived rather than for life as it is. Analysis of the activities of the ordinary or the unsuccessful strata of society may be fruitful in yielding difficulties or deficences not so readily seen in the most successful groups, but the higher strata are likely to offer the most effective methods of solving these difficulties. In fact, a very fruitful attack upon the curriculum problem is to contrast the methods or activities of the most successful people with those of the least successful and to train the next generation to follow the example of the most successful.

10. New fields. A much-needed type of research is that of collecting and organizing curriculum material for new fields that have never been taught before.

Without it, the addition of new subjects to the curriculum is impossible. As society advances, new problems arise and new difficulties are faced which call for training that was not needed in an earlier day. For example, new social and industrial conditions have produced changes which are seriously threatening the structure and life of the home. This presents a challenge for the curriculum maker to assemble material or pupil experiences which will prepare for home membership. The technique for work in pioneer fields of this kind is the same in general as that for older fields, but differs somewhat in degree. As a general rule such a field offers a better opportunity for truly scientific work than an older one, because there is less of the older structure to get rid of while building the new. For details of technique for this type of work the reader is referred to the chapters on job analysis technique and interview technique.

11. Emotional factors. A curriculum is a failure unless it produces actual improvements in conduct. To tell how to do a given act is not effective unless the telling actually results in better doing of that act. Facts are almost helpless in the face of emotions, but when properly charged with emotions, they become dynamic agents. The curriculum maker will not only endeavor to determine the activities which should be learned but also the ideals or emotional factors which should motivate and direct their performance. It is useless to teach *how* to be honest unless we succeed also in teaching *to* be honest. The curriculum must motivate the desirable types of behavior, and must therefore include reasons for performing them in addition to directions about how to perform them. Charters has stressed very much the importance of a two-dimen-

sional type of research on the curriculum, activities being one dimension and ideals the other. Briggs has given approximately a third of the space in his *Curriculum Problems* to a chapter on "Emotionalized Attitudes." The curriculum maker must not forget that the child is more than a mere intellectual being, and that training must reach the emotions as well as the mind and the hand.

12. Evaluating objectives. After a reasonably complete list of proposed or tentative objectives has been arrived at by analysis or otherwise, the curriculum maker is faced by the problem of evaluating them and selecting the most important ones. Frequency of mention is not a perfect basis for evaluation, even though it is a fairly suggestive one. Importance is to be considered as well as frequency. For example, some activities are engaged in only once or twice in a lifetime, such as getting married, and yet they are nevertheless of very great importance. Contrasted with this, we find such activities as tying one's shoes, which are performed every day but are relatively unimportant. In the absence of better methods it is often necessary to resort to the judgments of experts to evaluate objectives. Bobbitt submitted to the teachers of Los Angeles long lists of objectives which had been collected by his graduate students and let them approve or disapprove, add or modify according to their judgments of the needs of the particular locality. When such methods are employed, they should be used with the consciousness that the opinion of a majority does not necessarily establish a thing as the truth, and that the judgments of a few experts may be more reliable than those of many persons of lesser training.

13. Deriving pupil experiences from objectives.

Charters has called attention to the fact that a good aim does not necessarily issue into a good curriculum. Having set up the objectives that are to be achieved, the next problem is to find means of achieving them. These means are the pupil experiences, or subject matter, of the curriculum. Extreme caution is necessary to avoid jumping from objectives to subject matter without any assurance that the subject matter chosen actually achieves the proposed objectives. As a general rule some form of personal judgment or concensus of opinion will be necessary in performing this operation. Bobbitt had the teachers select the pupil experiences which they thought would best achieve the objectives agreed upon for their subjects.

14. Evolution versus revolution. The curriculum maker faces the same problem as every agent of social progress, whether to build upon what already exists or to discard it and start anew. The evolutionary plan would be to begin with the school subjects which we now have and make additions, substitutions, and eliminations, hoping ultimately to make it fit social needs. This is more desirable from the standpoint of temporary expediency, as in the case of the practical course-of-study maker, since it is more likely to result in something that can be put to immediate use, but it is not very desirable for strictly scientific work. The scientist will ordinarily find it preferable to forget the traditional moulds in which the curriculum is cast and to base his study upon life as it is actually lived. If the analysis of society finally results in such subject divisions as we now have, he will accept them, but if not he will not hesitate to discard them. Curriculum work by the evolutionary plan involves staying so close to the present practice that it is difficult to avoid falling

into the old established grooves, while the revolutionary plan enables the investigator to get farther away and work without this handicap. The revolutionary method has, therefore, far greater possibilities of progress in it than the evolutionary.

15. Prevailing practice. A very large amount of effort is going into curriculum studies which aim to discover what others are doing. This type of curriculum-making has been called the "Scissors-and-paste" method, since it ordinarily attempts to find out what to teach by imitating the example of others. It usually means that the blind are leading the blind, and it is not unusual if the imitators fall into the ditch along with those whom they imitate. It is based on the age-old fallacy that the majority is sure to be right. And yet this type of work has possibilities of real service if used with discretion. For example, if a number of schools are selected because of their demonstrated superiority of educational output and another group is selected because of their well-known failure to make successful members of society, then a study of the differences between the curricula of the two sets of schools might have some practical and scientific value. The wholesale and promiscous tabulation of prevailing practice, and the generalization that whatever is is right, however, is to be most emphatically condemned.

16. Psychological factors. The main emphasis in this chapter has been placed upon the sociological determiners of the curriculum. The psychological factors, however, should not be overlooked. The curriculum should be based on two main considerations, the activities of society and the nature of the individual learner. Children's interests have much to do with what is to be taught, as well as its order and arrangement. A most

fundamental type of curriculum research that is urgently needed is the discovery of the facts about child nature, particularly as it relates to the learning of the various types of subject matter. The psychology of school subjects is an essential unit in any complete program of curriculum making.

17. Child versus adult. In making an analysis of activities or difficulties for curriculum purposes, it is necessary to put the child in the foreground rather than the adult. To analyze adult civic duties ever so completely would not yield a suitable curriculum for citizenship to be taught to a child, because the child's civic duties are different. To teach a purely adult activity to a child requires that the training lie idle for a perod of years until the child reaches maturity. During this time it is forgotten and becomes of little or no value. A better plan is to find out what children do *now* and train them to do those things better, and thus plant seeds that will grow to fruitage in actual conduct as they get older. It is unwise to attempt to prepare for adult life by cold storage education during childhood.

18. Individual differences. Curriculum making would be simple indeed if all people were only alike! Individual differences complicate the problem and make its solution almost impossible. The activities of one person are different from those of another, making necessary a different kind of education. To take account of this, it is necessary to classify the persons who are included in the analysis into their various types so that each type is somewhat uniform and then to draw up for each type the kind of curriculum it requires. The same thing is necessary also on account of differences in intelligence, physical strength, sex, etc., making it

necessary to provide different kinds of training *even in preparation for the same life activity.* The curriculum maker can never hope to complete these various needed adaptations. He will simply carry his work to a point where the classroom teacher can take it up, and leave to her the final and more detailed adaptations to the needs and personalities of her individual pupils.

19. Grade placement. Much remains to be done even after the subject matter for the curriculum has been selected. It must be arranged in the proper order or sequence to give the training needed at each period in the life of the child. Certain items of knowledge that have great value at the time of puberty may be worthless if postponed too late, and worse than worthless if presented too early. The difficulty of subject matter must also be determined in order to avoid confronting the child with tasks which are too easy or too hard. Studies of elimination also have to be made before grade placement of materials can be definitely solved, since it is important to impart certain information even when it is premature accordng to psychological standards, if the probability is very great that the child will quit school before he would otherwise get that essential information.

20. Propaedeutic functions.. The question of the child's previous preparation for an advanced course is an ever-recurring one. College students are said to be deficient in grammatical preparation for foreign languages or in mathematical preparation for engineering, etc. In some of these instances the deficiency is real, in others only imaginary. It would be of considerable practical value for the present day, and possibly also for the ultimate advancement of curriculum science, if more studies were made to determine exactly what

the prerequisites in knowledge, skill, and attitudes for the various subjects really are. In one sense, however, such studies might be considered as merely "curriculum tinkering" because they would be of no value if a more fundamental type of research should lead to the abolition of the present list of school subjects and the recasting of the whole program according to different moulds.

21. Standards of perfection. In the case of some units of subject matter the problem is not "what" but "how much." For example, we are all agreed that handwriting and addition should be taught, but *to what degree of skill?* Certain early studies in this line attempted to solve the problem by asking successful men how much of certain abilities they thought were needed. More recently the device of finding out how much of these abilities they actually possess has been employed. For example, Washburne actually gave standardized arithmetic tests to outstandingly successful business men to find how well they could add, subtract, etc., and from the results drew conclusions regarding the amounts of these various abilities which are required for success. Standards arrived at by such methods should be generally preferred to those arrived at by personal opinion, even of experts.

22. Other educational agencies. The school does not have a monopoly of educational service. Home, church, playground, newspaper, etc., all play their various parts. The curriculum maker must not assume that his list of objectives for *education* are the objectives for *the school.* Which objectives to assume for the school and which to leave for other agencies to achieve is a problem calling for special research. Special investigations of the educational services rendered by

the Boy Scouts or the Y. M. C. A., for example, fall legitimately in the field of curriculum research.

23. **Measurement.** After a curriculum is made and installed, it should be evaluated by some kind of measurement. This can be done in a number of ways. One way is to try it out for a semester or a year and decide whether it works. This is usually done by merely subjective estimates of the teachers and other school officials. Quantitative methods are preferable. For example, the abilities of the children may be measured by objective tests before a new course is installed and again afterward to record change. The value of the course should be measured by its effects on the children rather than by the impression it makes on the teacher. For exact measurement it is often well to employ the experimental method, using two or more different courses, with as many parallel and equivalent groups, to determine their relative merits. Another plan is to administer standardized diagnostic tests after the installation of the new curriculum and observe the sections upon which the children make low scores. In other words, this method seeks to find the weak points and to apply additional training to fill the gaps. Well-kept age-grade tables would shed some light on the curriculum since undue amounts of retardation or acceleration at certain points would indicate how well the course was suited to the children. In closing, it is suggested that if the failures as well as the successes in curriculum-making were put into the records of society through publication much wasted effort would be prevented. Without this the same experiment may be tried out independently in several different places and abandoned in each case without ever a warning to others that it will not work.

EXERCISES AND QUESTIONS

1. Why is curriculum research one of the most difficult types of research?
2. Justify the emphasis which scientific curriculum making places on analysis.
3. List the factors or variables that should influence the curriculum.
4. Debate the relative importance of the child and of society as curriculum determiners.
5. Analyze the school situation with which you are most familiar and list as many curriculum problems for research as you can. Outline briefly a method by which each might be attacked.
6. Read the viewpoints of several writers on curriculum making and classify them according to their proposed methods of attack.
7. Read a report of a piece of curriculum research and criticize the technique employed.
8. What difference in research technique would there be between research on an old school subject, like arithmetic or reading, and a new one, like thrift or safety?

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CHAPTER VIII

JOB ANALYSIS TECHNIQUE

The procedure of job analysis is a very recent development, and one which has not yet gained as general recognition and acceptance by research workers as has been accorded to such older procedures as the experimental, historical, or statistical. In view of this general unfamiliarity with it, the following paragraphs of this section attempt to clarify its nature and purposes, after which other sections will deal more intensively with its technique.

I. Nature and Purpose of Job Analysis

1. Increased objectivity. Good workmanship in any line is to a large extent a question of personal opinion until it is analyzed into its elements. For example, a supervisor cannot judge teaching efficiency in the lump, except in a most subjective way, but two supervisors can arrive at very nearly the same estimate of a teacher if they use a rating scale which considers the various elements in teaching efficiency. When any complex object or process is studied in the lump, only crude judgments can be made, but if the various component elements are separated and studied independently, it may be possible to be entirely objective and scientific in dealing with each. The trouble with study or research devoted to a thing in the lump is that there is usually a large amount of opinion or generalization about the proportions of the various elements which go to make it up. The chemist has found it necessary to use the element rather than the compound as the basis for his science in order to be strictly objective and

scientific, and likewise, the scientist who deals with human activities must analyze them down to their objective elements.

2. Greater accuracy in job description. The effort to tell what a school principal's job actually is requires a job analysis of the principal's work. In other words, it demands a careful study of the *content* of his job. This would involve making a complete list of the duties or functions which he performs, or the particular activities which occupy his time. This amounts to a dissection of the principalship and a description of it in terms of specific tasks, such as interviewing new teachers, conferring with parents, signing attendance cards, etc. Until such a job analysis is made, no one knows exactly what a principal really does, or how his effectiveness can be improved. The few such studies that have been made have revealed that some high-salaried school officials, and likewise business executives, were doing the work properly belonging to low-salaried clerks and secretaries. Description of a job is not an end in itself, but it is extremely essential as a basis for further scientific study of it, just as description of a new disease germ is basic for the work of the medical scientist in developing a scientific method of controlling it—or, to change the figure, dissection of jobs to discover their elements serves somewhat the same function in personnel science as dissection of organic tissues has served in the science of physiology.

3. Improvement of practical efficiency. As the name implies, job analysis concerns the practical worker. It originated in the vocational and industrial world. It has to a large extent been used as a servant of vocational education, looking to improvement of the

performance of practical processes. It is the outstanding technique for assembling helpful material on methods of performing the work of a given occupation, for which purpose it has been devised. Yet, its use need not be limited strictly to occupational activities. It is applicable to the whole range of human affairs, to anything that involves behavior or perfarmance. Is not being a good citizen or being a lover of literature an activity or performance which is subject to improvement? If so, is there not need for analyzing the activities of citizens or book lovers to find how the better practitioners of these arts perform them? If education is to change or improve human behavior, is not all education in a sense a practical training for increased efficiency in performing some kind of activity or job? In this sense, job analysis is basic to all education, and is, as has already been recognized, the foundation upon which curriculum making must ultimately rest.

II. Job Analysis in Personnel Work and Administration

Job analysis is of fundamental importance to the executive or administrator. It has been one of the central features of various systems of scientific management, and was used extensively by the United States Army in perfecting its tremendous organization. There are numbers of urgent educational problems of an administrative type which call for the use of this procedure, of which a few are discussed in the succeeding paragraphs of this section.

1. Selection of employees and vocational guidance. In securing a new teacher for a school, or a new member for its administrative staff, it is as important to

know the characteristics of the position to be filled as of the applicant who is to fill it. Matching employees and jobs effectively calls for detailed study of each. The study of the applicant does not concern us here, since that task has been analyzed in some detail in the chapter on case study technique. But it is important to stress here the need of job analysis as a basis for job specifications. It is impossible, for example, to know whether a certain position requires a man or a woman, until the nature of the position is analyzed and clearly defined. Likewise, standards regarding age, training, experience, intelligence, etc., can be set up only in the light of the actual duties and responsibilities which are involved in the job. Some positions require high intelligence and much initiative, others of a more routine nature are better filled by persons of lesser talent who will be content to remain in them on low pay and without rebelling at the monotony involved. Which type of person to select for a given job can be answered only by finding out definitely the activities included in it.

The other side of this same question is the problem of vocational guidance. In order to give intelligent advice to a student regarding the work for which he is to train, it is necessary to have definite information about the jobs between which he is to decide. Before recommending law, medicine, or teaching to a student in college, the duties and demands of these callings must be known. If a given individual has a physical handicap, or a speech defect, a job analysis of a number of callings, or a number of positions within a single organization, would probably reveal the job or jobs which such a person could fill successfully.

By way of summary, it is reasonable to think that

there is a best man for every job and a best job for every man, and that the task of matching men and jobs will be greatly simplified by making a careful study of the exact nature of each.

2. **Conservation of talent.** Much has been said in recent years about conservation of natural resources, but the conservation of human talent is of greater importance even than this. It sometimes occurs that a small man gets into a big job, but he usually fails to perform his duties satisfactorily and is discharged. But a big man not infrequently gets into a small job and stays in it indefinitely because no one recognizes his capacity for a more responsible position. Business concerns have been known to reduce their overhead charges enormously by hiring clerks to do work formerly done by high-salaried executives who had really been doing routine work. It took job analyses by so-called efficiency experts to direct attention to the waste of talent that was going on and to bring about a remedy.

3. **Determining systems of promotion.** A common school policy in the past has been to fill administrative positions by promoting successful classroom teachers, often as a reward for work well done, yet we may at least raise the question as to whether there is not some better source for administrators. Is the teacher's work the most natural and effective training for the work of administration? Is the principalship the natural culmination of a career of successful teaching? Or is the superintendency the natural step after the principalship? Or should the successful elementary teacher be promoted to junior high school, and thence to high school, and finally college teaching? No adequate sequence of jobs or routes for promotion can

be determined and scientifically evaluated except in terms of objective studies of the duties and responsibilities of the jobs concerned.

4. Setting limits of responsibility. One of the central features of scientific management is "functionalization," or establishing definite limits of responsibility for each workman and each executive or staff officer. In other words, it is a scientific rather than a haphazard division of labor between the various employees in the organization. Some of the published school surveys have revealed undue overlapping of jobs—so great, in some cases, that three different persons were responsible for the same taks. Other duties were discovered which were not assigned to anyone in particular, and were being almost entirely neglected. Job analysis is the method by which the executive may determine how to organize his staff so as to establish clearcut lines of responsibility, and at the same time have the division of labor conform to the most natural or efficient standards. The various duties and responsibilities cannot be parcelled out among the different employees until the whole list of duties and responsibilities has been determined. A job analysis of the "reservoir" type, which lists all the duties of all the workers, may be made the basis for a redistribution of the various jobs among the various workers in the light of a broad perspective or bird's-eye view of the system as a whole, resulting in a more effective and economical division of labor and a greater degree of coordination of the efforts of all in the common undertaking. If a science of school administration ever comes into existence, it seems reasonable to expect that it will rest quite heavily upon job analysis as one of its fundamental techniques.

III. Job Analysis and Training

One of the principal uses of the job analysis technique is involved in the field of methods. For example, if it were our desire to organize a training course for teachers of gifted children, or for coaches of athletics, or for elementary school principals, we should either develop the course by haphazard means or else organize it from the results of a careful job analysis study. The principal steps in the latter process are outlined in the following paragraphs of this section.

1. Difficulty analysis. The first step in preparing a training course for any job is to discover the parts of the job which present difficulty, or which are imperfectly done. There is no need of giving training in matters that are already perfectly done. Economy demands that the major effort be spent in remedying the deficiencies that exist. These difficulties, deficiencies, or errors may be discovered in many ways, but making a complete list of them calls for a rather systematic search. The investigator might begin by listing all difficulties he has observed or experienced. He may supplement this by reading, by interviewing various people who are engaged in the job, by making systematic observations of them as they work, and by having them list their difficulties in writing. Every difficulty, however large or small, general or specific, important or trivial, might well go into this preliminary list, in order to get as many leads or clues as possible. It will ordinarily be impossible to follow up each of these by a search for methods of doing it, because of the enormous amount of labor involved. Nor would it be desirable to do so, because such a list would probably still be far from complete

and would thus cause a neglect of all difficulties not definitely included.

This fact suggests the need of classification of the list of difficulties into working groups or types. When one hundred or more specific difficulties have been assembled, they will usually group themselves into a dozen or more major classes, after which several more specific difficulties will begin to be noticed to add to each group. For example, locating a few children in a family may help to locate their parents, and by observing the movements of the parents for a period, the remaining children of the family are likely to be discovered. This classification of specific difficulties into working units amounts to a determination of the chapter titles for the textbook which is to be prepared for the training course, or the topics which are to be made the main lesson units in the course.

Care should be taken to arrive at the above-mentioned chapter divisions by classifying specific difficulties rather than by subdividing the field as a whole, since the latter is almost certain to be a structural rather than a functional classification, and since the former is much more likely to result in a group of difficulty-units which are mutually exclusive and all-inclusive.

2. Collecting methods of solving each difficulty. After the difficulty analysis has been satisfactorily completed, the search for methods begins. In order to be sure that the methods discovered are truly applicable to the difficulties, the latter should be expressed in the form of questions of the "How to ——" type, as "How to handle disciplinary cases sent to the office by the classroom teacher when the teacher is in the wrong." Unless a difficulty can be expressed

in this form it is really not a difficulty, or else the difficulty has not yet been clearly defined in the investigator's own mind. Having been so defined and formulated, the difficulties might well be given serial code numbers for ready identification, and for ease in keeping methods associated with their respective difficulties. Then every method which is discovered may be written on a small card and given the number of the difficulty to which it applies, all methods for a given difficulty being filed in the same place. This process of collecting methods would be carried on until no new methods were to be found, or else terminated at such a point of thoroughness as practical considerations might require. The sources of methods would naturally be chiefly in the practical workers themselves, as they are the people who supposedly know how to do the job which is being studied. Certain other sources may at times be available and desirable. The detailed technique for collecting methods is not given here, the reader being referred to later paragraphs of this chapter and also the chapters on interview technique, observation technique, and curriculum-making technique, for fuller directions on these points. The essential point here is that *all possible methods* or suggestions on how to solve the respective difficulties should be assembled. The basis of selection or rejection should be *relevancy*, since it is important to have all methods at hand, however good or bad, when the stage of evaluation is reached. The merits of the different methods should not be of any great concern to the investigator during the collecting stage of the study. Evaluation should take place later, and on a more scientific plan than is feasible during the collection stage.

3. Evaluating alternative methods. The usual reaction of a person who has conducted a job analysis study involving the collection of methods of solving a set of difficulties is something like this: "I didn't realize there were so many different ways of doing the same thing." How, then, are we to know which is the best of several ways of doing a thing? There are several possible ways of evaluating them: (1) They may be compared experimentally or statistically, under carefully controlled conditions, with strict forms of measurement, and their relative merits established by objective and thoroughly scientific evidence. This is usually a laborious task, and no one investigator would be able to conduct more than a very few such experiments, even if he devoted his whole life to the task. This must ultimately be done, however, in order to get final and absolutely dependable evaluations. (2) The methods reported by highly successful workers may be contrasted with those of workers of lesser ability. Comparisons of extremes in this way may shed considerable light upon the relative values of the methods they employ, although it does not necessarily establish the facts conclusively. (3) The reasons for the various methods may be collected along with the methods themselves, and thus form the basis for an empirical or common sense sort of evaluation, which, while not final and scientific, is better than no guidance at all. (4) The various methods may be tested in the light of the fundamental psychological and philosophical principles which are commonly accepted as true, the investigator doing most of the work of judging. (5) The entire list of methods may be submitted to a group of successful workers in the field for rating or ranking as to their relative merits.

It will frequently happen that one investigator's time will be sufficient only to complete the collection phase of the study, as in the case of a student working on a master's thesis problem, and that the other steps will have to be completed by other investigators. In such cases, care should be taken to present the methods collected simply as alternative or proposed methods, and to avoid leaving an impression of finality about them. Until methods are evaluated, they should be clearly branded as tentative and might well be labeled, "To be used at your own risk." It is better to have available a number of mutually contradictory and untried methods as a source of suggestions than to have nothing at all upon which to rely for guidance in facing a difficulty.

IV. General Problems of Procedure

Having treated briefly a few of the special considerations involved in job analysis in administration and in training, we are now ready to treat some of the general problems and procedures in actually making a job analysis investigation. Many of these procedures will be as applicable to a study for one purpose as for another.

1. Limiting the field of investigation. There is nothing to be gained by making a job analysis for its own sake. Unless there is a definite purpose behind it, it should not be undertaken. If there is such a purpose, the investigation should be limited to a scope that conforms to that special purpose. For example, an industrial concern may be primarily concerned about wages, or accidents, or labor turnover. Or an educational institution may be concerned with reducing pupil failures, saving building space, or reducing the

cost of instruction. For practical purposes, the individual investigator, working alone, should limit his efforts to a single problem of a rather narrow scope and do that one thing well. Also, as a rule, the study should be limited to a *functional* analysis rather than attempt a complete *structural* analysis. That is, the point of view should be that of behavior units rather than that of logical divisions of the field.

2. Getting access to the needed information. There are many ways of getting the actual information needed in making a job analysis. A few may be briefly mentioned here. Several of these are discussed at greater length in other chapters.

(1) *Personal experience.* Efficiency engineers and job analysts are not uncommonly persons of considerable experience in the general type of work they are investigating. If an analysis of methods of teaching Spanish is to be made, it is ordinarily best for an experienced Spanish teacher to conduct the analysis. In the absence of such experience and direct contact, it has at times been found worth while to go into the job as an apprentice and make the job analysis concurrent with the learning of the job. In the industrial field it has been necessary at times for efficiency engineers to work as common laborers in order to get the intimate acquaintance with the work that was needed.

(2) *Observation.* Next to doing the job himself, comes observation by the investigator of other persons as they do the job. It reveals some things that are not discovered by practical experience on the job, because a more detached and impersonal viewpoint is possible. It also yields richer results because it makes available the experience of many workers instead of

only one. When it is supplemented by the use of stop watches, photography, etc., it may be of enormous value.

(3) *Workman cooperation.* When the experience and observation of the investigator are supplemented by that of the various individual workers, the result is very much enriched. The workers should ordinarily be taken into the investigation, their whole-hearted consent gained, and enlisted in an active effort to secure complete information on the problems being attacked. Anything that arouses suspicion or which resembles an attempt at exploitation is naturally resented and causes the doors to be barred against access to the desired information, and there is much needed information that can be gained from no other source than the actual workman on the job.

(4) *Personal interviews.* Many facts about a job which would naturally escape the eye of an observer will be discovered through personal interviews. The presence of the interviewer makes possible a thorough searching of the experience of the person interviewed, until the desired information is brought to light. It is a device for securing the results of self-analysis of the persons interviewed and also of their observations of their fellow-workers.

(5) *Written reports or questionnaires.* The use of questionnaires in job analysis, as elsewhere, is subject to question, and should be resorted to only after due consideration. Its advantage of economy of labor is usually more than counterbalanced by its disadvantage of reduced returns. Only when there is some form of exceptionally strong authority or motivation, can it be made to yield worth-while results.

(6) *The use of assistants.* Some of the best and most

extensive job analyses have involved the services of numbers of hired assistants to make the necessary observations, interviews, etc. This device makes possible a much more comprehensive and thorough analysis than would otherwise be possible, and if the assistants are carefully trained so that their methods are uniform and on a high plane, their work need not be inferior in quality to that which the investigator would do himself. There are possibly many cases in which a group of students working under the direction of a well-trained teacher could carry out a job analysis with profit to themselves and perform a real service to science.

(7) *Tests.* Sometimes the information needed can be gained in a better way by actual tests than by observations and interviews. For example, if we desired to learn the amount of mathematical ability required of a bookkeeper, it would probably be best to administer well-chosen mathematics tests instead of asking him how much mathematics he thought he needed or used. Special tests would have to be made for some problems, but the trouble would be justified by the improved results.

(8) *Reading.* Something in the way of published information is available for practically every job imaginable. In such fields as teaching and administration, a rather extensive occupational literature has been built up. Two cautions should be observed regarding the use of this material in job analyses. One is the caution against ignoring or slighting it. The other is the caution against using it to the total exclusion of other sources of information. As a general rule the best and most helpful information about how to do any job is to be found in the unrecorded experience of

those who are doing the job, rather than in the published literature on that occupation.

(9) *Original thinking.* The job analysis investigator must be more than a collector and compiler of methods. He must, to a certain extent, become an inventor of methods, using the suggestions of others as raw material to combine in new ways. By the time he has worked intensively on a problem or job for a long period of time he is probably more fertile with suggestions for new procedures than any other person, and it would be unfortunate if, in his effort to be objective and impersonal, he should fail to record the results of his own thinking about the job. The fact that methods which he invents are not actually practiced by any single workers at present need not be a serious objection, since the evaluation of methods is a different and later process than the collection of methods.

3. Securing variety of samplings. Representativeness is as essential in job analysis as in other forms of research. For example, it would be unwise to base a job analysis of college training upon a single collegiate institution and then draw inferences from it regarding college teaching in general. Furthermore, in order to get the richest and most complete information about a job, it should be analyzed as carried out under widely varying circumstances. A course on salesmanship would not be as rich in helpful procedures if it were derived solely from salesmen behind the glove counter as if it had been based upon the work of salesmen of suits, furniture, real estate, stocks and bonds, and so on. Methods secured from beginners will supplement the returns from persons of long experience, because they are keenly conscious of certain things they do which experienced persons have already automatized

and forgotten. Elementary school teachers will contribute methods not given by high school teachers, and principals can give points on teaching as seen from the administrator's viewpoint which would not be gained from the teachers themselves. Customers can give information on some points of salesmanship which salesmen themselves would not think of, just as students can about methods of teaching. The total composite of activities, difficulties, or methods is greatly increased when the variety of types included in the sampling of workers in a job that is analyzed is increased.

4. Resorting to judgment and inference. There is a strong temptation to list imaginary requirements or elements of a job as real ones. For example, it seems reasonable that an engineer would need to use a great deal of mathematics, and unless the investigator is especially on his guard, he may rate mathematical activities higher in the engineer's job than the actual facts warrant. Then, again, there is a strong temptation to make a wild mental leap from what a man *does* to what he ought to *study* to prepare for his job. Against such errors on one extreme are errors of excessive objectivity on the other extreme. A complete job analysis must take account of many of the personal or human elements in addition to the purely mechanical and strictly objective ones. The things a worker feels, wants, likes, and aspires to are as essential to an undertaking of him as are the things he does with his hands or the devices he employs in manipulating his tools. Frequently the only way to discover the former is by the use of judgments and inferences based upon the latter. Many of the most important elements in a job are of this subjective sort. The investigator will, therefore, be obliged to proceed thoughtfully and

critically and be alert to discover what is only suggested or implied as well as what is obviously present, but always on guard against unrestrained flights of imagination, or deception by misleading suggestions.

5. Composite versus typical lists of elements. Job analyses fall into two general classes as regards their purposes. One is the class which seeks to get a composite list of all the elements in the job as it is practiced by a large number of workers, or a list of all the methods known by a number of workers, regardless of the frequency of occurence of a given element or method. In other words, this type seeks to discover the complete range of elements, or to be all-inclusive. The other type of job analysis seeks to list the things that are found to be common to all or to a large portion of the different workers, and ignores those elements or methods which are peculiar to individuals or small groups. Whether it is better to make a composite list or a typical list depends on the purposes of the particular study, but usually the composite list is an essential preliminary to the typical list. That is, it is generally best to discover all the elements or methods first and then conduct a special investigation of a more statistical sort to discover the frequency of occurrence of the various individual elements in the lives of the different workers. This point will be elaborated a bit further in the paragraph on the use of checking lists.

6. Keeping records. The records for a job analysis are ordinarily more bulky and voluminous than for most other types of research. The problem of preserving order and system is accordingly an unusually important one. The following points suggest a few things that experience has shown to be of value in this connection. (1) Reduce the results to writing.

It is absolutely hopeless to trust the memory because the mass of detail is entirely too great. (2) Adopt some kind of code numbers or other observations to stand for much-used items in order to reduce writing as much as possible. (3) Keep all notes numbered or identified objectively so that they can be sorted and classified for filing without reading their contents. (4) Put the record for each element, difficulty, or method on a separate small card to facilitate ready recombination or reclassification, and to facilitate the discarding of duplicates. (5) Avoid throwing two or more closely related points or elements together into one entry in the records. If a separate entry is made for each they can still be combined later if necessary, but if once combined, they can never be separated if later needs call for it. This idea has been expressed by the old saying that "you can't unscramble eggs". (6) Be sure the methods or practices are described so completely in the records that the description would enable other persons to repeat the methods or practices in exactly the same way. Otherwise, there is no certainty that the methods or procedures which are recommended for general adoption will be correctly understood or adopted by those who are to use the results of the study. (7) Either keep a record of the new contributions received from each additional worker analyzed in order to know when the point of complete saturation is reach, or else continue the analysis far enough to be sure that the saturation point has been reached or passed. As a general but only approximate rule, thirty persons of a given class or experience background will contribute enough elements so that a composite list will not be materially increased by including other persons of that same class or group.

7. The use of the check list. As was mentioned previously, it is sometimes desirable to know not only the complete list of all activities or methods that are represented by a group, but also their relative frequency, amount, or importance. For this purpose the check list is of considerable service. It may be briefly described as a list of all items on the composite list arranged in a form convenient for checking by the individual worker beside each item. For example, the list might contain twenty-five tool operations of a brick layer for each individual bricklayer to check or rank as to their status in his own individual work. Such a list must of necessity be compiled by job analysis procedures in the first place, but when it is once prepared, it makes possible a quantitative investigation and evaluation of the material included in it which is often of very great service. F. C. Ayer has made such a study of school administration, in which he assembled a list of one thousand specific administrative tasks that have been known to be performed by one or more superintendents or principals. He then printed these in pamphlet form and had large numbers of administrators check the approximate number of times they did each task per day, week, or year. The amateur in job analysis would possibly attempt to combine these two phases of the study into one as he went along, but doing so would only hamper progress in preparing the original composite list without yielding any quantitative data that would have scientific value. The use of the check list is a comparatively simple task, once the composite list has been made.

In this connection a warning should be given against attempting to use the check list as a means of preparing the composite list in the first place. If a list of

one hundred items is presented to a man, and he is asked to check those which apply to his job and to add to the list other items not already included, he may do the checking satisfactorily, but he is almost certain not to add much to the list. His new contributions are easier to get if he is not confronted with a previous list.

EXERCISES AND QUESTIONS

1. How does the need for job analysis in education compare with the need for it in the industrial world?
2. What is an "efficiency expert," and how does he work?
3. What are the peculiar dangers that lie in the job analysis type of research as regards its strictly scientific character? How can these be avoided?
4. How does the need for job analysis in administration compare for the need of it in training?
5. Referring to the chapter on curriculum-making technique, see how many parallels you can draw between it and job analysis technique.
6. Read several authors on job analysis and compare the different meanings which they associate with the term. What other terms do you find used to express the job analysis idea? Which of these seems preferable?
7. Make a list of research problems presented by your school situation that might be attacked by the job analysis technique.
8. What would you consider the best way to prepare for the making of a job analysis investigation?

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CHAPTER IX

INTERVIEW TECHNIQUE

1. Selecting subjects to be interviewed. The policy to be employed in selecting persons to be interviewed depends upon the purpose of the interviews. The following points, however, will be of some importance in most cases: (1) The persons interviewed should know a great deal about the matter upon which the interview is to be based. They should have had experiences which are worth sharing, and which are really important. They should be more or less expert in the things about which they are to report. (2) They should represent a variety of types, or a wide range of experience. The aim in most interviewing is to get diversity rather than uniformity, and hence the more varied are the viewpoints and backgrounds of the subjects interviewed the richer the returns. For this reason it is often well not only to interview teachers but also supervisors, and even pupils, in order to get the most complete returns upon a question about methods of teaching. (3) It is usually better to hunt for "big game". The persons of larger calibre have more to contribute, and, contrary to what might be supposed, are more likely to be courteous, considerate, and willing to help. They have become accustomed to being called upon for conferences and have a portion of their time definitely set apart for such things. (4) One interview may be used as a means of discovering "leads" to other promising sources of information. Remarks made in the interview may suggest other persons who would be

likely to have valuable information. In fact, it may be well at the close of each interview to ask for such suggestions and write them down. Care should be taken, however, not to let the giving of such information be used by the subject as a means of dodging the task of giving what he himself has to offer.

2. Enlisting cooperation. The success of the interview depends on how well the interviewer "sells himself" to his subject. It is often necessary to give considerable thought to the methods to be used in breaking down mental resistance and getting free and unrestrained responses. The following are some suggested ways of doing this: (1) The interviewer should think the matter through for himself quite thoroughly and know enough about the questions to be able to satisfy the subjects to be interviewed that he is capable of using the replies intelligently. (2) The interviewer should be keenly interested in the questions himself, else he cannot expect his subjects to be interested. (3) The interviewer should take his subjects into his confidence, telling them the nature of the problem being investigated. Any trace of secrecy immediately sets up psychological barriers that are almost insuperable. (4) It is usually better to introduce a considerable element of formality. That is, the interviewer should make it plain that he wishes a serious interview rather than a casual conversation. Such plans as meeting at lunch tables for an "interview" while eating a hurried meal are unfavorable to setting up the kind of mental attitude desired.

3. Getting introductions. The securing of an interview is sometimes aided if the interviewer is introduced to his subject by some third person who is in a position to sponsor him or his investigation. The faculty mem-

ber who is directing and supervising the research is usually in such a favorable position, and can do much to smooth the path for the interviewer. The greater the prestige of the persons arranging the introductions, or the closer their acquaintance with the subjects to be interviewed, the more effective are the introductions. Not uncommonly the interviewer will find it best to go directly to a superior official, like a school principal, present his case, enlist his cooperation, and get him to arrange with those working under him for the desired interviews. Again a form of implied introduction that is almost always possible is that of telling the subject who is to be asked for an interview the names of persons who have already granted interviews. This serves somewhat as a testimonial to the worthwhile nature of the project, and is a fairly good opening wedge.

4. Appealing to personal pride. Vanity seems to be an inherent attribute of practically all people. There are numbers of ways in which the interviewer can use it to further his ends. For example, he may find out beforehand what special thing his prospect has done, or what special kind of information he possesses, and approach him from that angle. The prospect is naturally pleased to know that his expertness in this line has been recognized and that he is considered an authority on the subject, and in his general feeling of expansiveness is more likely to grant an interview. This reaction is enhanced if the interviewer makes it clear that not just anyone and everyone is being asked for interviews, and that the requests are being made of only a selected few who have much to contribute. The same effect can be maintained during the interview itself by the simple device of reacting to the subject's

statements as if they were weighty contributions and recording voluminous notes upon them whether they are of any importance or not.

5. **Making appointments.** A definite appointment for an interview should usually be made beforehand. Chance meetings are seldom satisfactory. A personal call to ask for an appointment is almost always preferable to a request by telephone or letter. It is well to ask for more time than will probably be needed rather than less, because this emphasizes the importance of the project and produces a more favorable attitude. The interviewer should be willing to make any reasonable arrangement for a meeting that is suggested by the prospect, considering his own time and convenience of no importance. To get impatient or cross because a person forgets his appointment or is delayed is distinctly out of place, since "beggars should not me choosers." If a person is unable to grant an interview at the time asked for, it is best to set a definite date as far ahead as necessary, and then to call him on the telephone the day before to remind him of it. It is especially bad policy to agree to meet "sometime" or to depart with the understanding that the prospect will call up the interviewer when he has a convenient time for the interview. Such an arrangement takes the situation out of the control of the interviewer almost entirely. The time set for an interview should be such that there will not be a rush or hurry to get through. It is better to postpone the interview entirely than to sacrifice the opportunity to get its full value by attempting it under unfavorable conditions. The same considerations apply also to the selection of a place where the interview is to be held. At the close of an interview, it is well to leave the way open for a

second interview in case it is discovered later that any essential items have been overlooked.

6. Framing questions. The interviewer should have definite questions in mind to ask, instead of taking each subject's ideas according to the order or arrangement of the giver. The questioning should be planned with great care to draw out as much and as valuable information as possible. Even in cases where reasons of tact or diplomacy require that questions be kept in the background and that the interview progress as a "spontaneous" conversation, the questions should be distinctly present in the mind of the interviewer. In some cases the questions should be made in full and then summarized each into a key word or phrase which is meaningless to anyone except the interviewer in order to provide definite guidance without playing into the hands of the person interviewed. A good rule in framing the questions is to confer with someone or try them out in a rehearsal interview and revise before going into the regular series of interviews.

7. Number of questions. The matter of number of questions has two aspects. (1) How many questions to include in the entire list. (2) How many to ask any single individual. The number to include in the entire list depends upon the degree of thoroughness with which the study is to be made. The finer the analysis of the total problem, the greater wealth of detail will be secured, but the greater the labor of getting answers to all the questions. The more questions there are in the list, the more nearly alike are the individual items. In fact, it is possible to split questions up into parts that are so small that the ordinary person who answers them will be unable to see how they differ from one another, and will tend to make the same response to

several different kindred questions. The writer's experience has been that it is usually best to have one question for each chapter in the book or thesis which is to be based on the replies. This means that the field will ordinarily be divided into not more than fifteen or twenty divisions, with one question to each division. The other phase of this problem is how many questions to ask in any single interview. The answer is, from seven to twelve, as a general rule. To attempt more than this results in fatigue and reduced quality of answers to the last questions. It is better to ask only half the questions in the entire list and come back for the other half, or to ask another person the other half, than to rush through a long list superficially. The longer the interview dwells on a single question, the richer the returns that are secured.

8. **Number of interviews.** The fruits of successive interviews are subject to the law of diminishing returns. The first one yields all new material. The second adds some new material and some that duplicates the first, and so on. Charters has suggested that about thirty interviews on a given question is a suitable limit, and that further interviews after that point are often not worth the time required. Mrs. Woodruff* kept a record of the number of new ideas gleaned from each of her interviews, and found that while the 27th and 28th interviews yielded 24 and 29 ideas respectively, they yielded no *new* ideas at all. If further information is desired after reaching such a point, it is obvious that additional interviews of this type cannot be expected to supply it. It is necessary to adopt a different

*Hazel M. Woodruff, *Method of Teaching Current Events.* Unpublished master's thesis, University of Southern California, 1927.

method, a different set of questions, or else go to persons of a different background of experience who will not simply duplicate the answers of the previous ones. If a large number of persons are to be interviewed, it is better to divide up the questions and the subjects into sections, and interview each section more intensively on its special portion of the entire list of questions.

9. Self-interviewing. Before the interviewer proceeds to ask other people his questions, he should interview himself very thoroughly. If he writes out his own answers he has a better understanding of the issues, as well as a greater capacity to appreciate the mental states of those who are to respond. Furthermore, if his own ideas are to be preserved at all, they must be recorded before the ideas of other persons are secured, else the two coincide and originality is sacrificed. Self-interviewing should not cease, however, when the interviewing of others begins. The interviewer should record his own ideas whenever they occur to him, whether in the midst of an interview, while writing up the results later, while organizing the returns from several interviews, while walking through the park, or at any other time. By the time he has given a problem as much consideration as is involved in a series of interviews, he naturally has some valuable and original ideas upon it which it would be unfortunate indeed to discard.

10. "Digging deeper". The first reply to a question is likely to be the natural result of the laws of association, and will bear a striking similarity for the various persons interviewed. In order to get more than this superficial or conventional reply, it is necessary to dig deeper into the subject's experience by follow-up ques-

tions until those unique contributions which are peculiar to him have been discovered. The ability of the interviewer is quite effectively measured by his ability to hang on to a question until it yields valuable information. If a reply is not understood, or if it seems to lack significance, further questioning is required to bring out the real idea behind it. If a person's mind is kept upon a given question long and persistently enough by skilled interview technique, it is almost certain to yield something that will be of value to the interviewer.

11. Varying the terms. When a given question has elicited all the information of which it seems capable, it is time to state it again in different words and thus get a second installment of information. The same question may be presented over and over in this way, each time bringing forth new material. Ideas that are not aroused by one word may be aroused by its synonym. Thus, to ask for "methods" gets one response, "devices" another, and "suggestions" still a third, and a question has not been exhausted until it has been asked in several such ways. This idea also has an important corollary in the use made of the replies received. The same general thought may be contributed by several different persons, each in slightly different phraseology. To record it only once, and ignore it thereafter as a duplication, is very unwise. It is better to record it each time, in the phraseology of the speaker, and then to assemble all these various kindred statements later, where the slight differences will call up in the mind of the investigator their slightly different shades of thought.

12. Asking how. A common error of interviewing is that of asking "Do you——" rather than "How do

you——". The former type yields simply a yes or no answer, while the latter yields valuable methods for the guidance of others. If the purpose is to make a survey of prevailing practice, calling for the "Do you——" type of questions, the interview method is not suitable, because it is too laborious to permit the recording of enough cases to afford an adequate sampling. Such questions had better be presented by questionnaires and answered by several hundred persons. Not only should the interview question be stated to include the word *how* but the interviewer should make extra effort to insist that the answers received actually answer that question. Also, it is frequently necessary to ask additional how questions with respect to a method that is reported, in order to get more detailed information on how to utilize that method.

13. Precept versus practice. Whether to ask questions in the form "How to——" or "How do you——" involves a very fundamental issue in this type of research. The issue is whether to find what is actually practiced, or to find what are the possible or desirable ways which might be practiced. If the goal is the collection of facts, it is better to ask a person how he does the task; but if the goal is to collect suggestions, it is better to ask him what are the various ways of doing it. The latter obviously yields a wider range of methods, while the former yields selected methods that have to some extent been tried out and found to be workable. There are cases, however, when asking only for how a person does a task would uniformly neglect the best methods, as in the case where the best methods have not yet been adopted in actual practice. The writer's preference in most cases is for the "How to——" type of question.

14. Examples. For each method secured in an interview, it is desirable to get at least one illustration. The simple device of asking "For instance——" is of enormous value in improving the results of interviews. Without it the points are likely to be somewhat abstract at the time, and possibly meaningless weeks later when they are being assembled and organized into the final report.

15. Asking why. If methods and policies discovered through interviews are to be of service in the guidance of other people, they must be interpreted, explained, psychologized, or justified. Merely to know a way of performing a task is useless unless there is a reason or motive for adopting that way. It is for this reason that the interviewer should not be satisfied when he has learned how, but should go a step further and get the special merits or advantages of the methods reported. The reasons for not doing it a certain way are as important as the reasons for doing it that way, since the disadvantages or weaknesses of a method may be as important to know as the advantages.

16. Keeping on the subject. It is the interviewer's responsibility to guide the course of the interview, and to bring it back if it tends to wander. This requires clear thinking and a logical turn of mind, or else the returns from the persons interviewed will be in a muddled state. There are a few devices, however, which may prove helpful in holding the interview upon the subject. To have the list of questions prominently displayed is a constant reminder that there is a definite business to be attended to, and by constantly referring back to this list, it is possible to break up irrelevant trends, and to bring the subject back to the desired topic. Without such a list of questions or topics to

lean upon, it is at times difficult to direct the course of the conversation properly without seeming a bit rude or autocratic.

17. Flexibility. A rigid adherence to a prepared list of questions is seldom wise. It is well to skip about in the list, if by doing so a better set of responses can be secured. The principle, "strike while the iron is hot," also necessitates following up a train of thought at the time it is under way instead of shutting it off merely because it is not the next thing on the list. Someone has compared interviewing to boxing, in that it is necessary to take advantage of the openings when they occur, lest by a delay the opportunity be completely lost. It sometimes happens that a certain question is particularly suitable as an opener for the interview for one person, and another question for another, according to their special interests and backgrounds. As in the case of observation, it is sometimes best to take the impressions or statements from the person interviewed, just as they come, and to fit them into their appropriate categories later at leisure. At any rate, it is necessary in practically every interview to take up a new piece of paper and record material that answers a later question and then when that train of thought runs down, come back to the question that was being discussed before the interview wandered.

18. Arguing. A good slogan to keep in mind is that "the person interviewed is always right". It is wise to question or doubt the views expressed only when such a doubt is used to bring out the reasons back of the views expressed. The interviewer should be eager to learn rather than to teach, and to avoid imposing his views or opinion upon the person interviewed.

19. Revealing the questions beforehand. There are

times when it seems best to leave a list of the interview questions to be studied over before the interview. This improves the results, in that it, at least theoretically, causes more thinking to be done on the answers. But as a matter of fact, it usually detracts more than it adds. Usually the questions are considered only superficially if at all before the interviewer arrives. If, however, they are studied over with great care before the interview, the result is not pure gain. In such a case the interviewer gets the *end result* of the thinking process and misses the *intermediate steps* in the thinking which were carried out before he arrived on the scene. These intermediate steps are often as valuable or more valuable than the final decisions to which they lead. There is a yet more serious disadvantage in leaving the question beforehand. It takes the control of the interview out of the hands of the interviewer and puts it in the hands of the subject. Or, at best, it results in a dual control, which greatly handicaps progress. If only the interviewer has possession of the questions, he can hang on until he is satisfied, but if the subject has them, he can set a more lively pace and bring the interview to a close before the interviewer has secured all the information he needs.

20. Confidential information. Before best results can be obtained from some people, it is necessary to assure them that "What they say will not be used against them." Usually it is only necessary to give assurance that names will not be published in connection with statements, but in other cases, it is well to give the person involved an opportunity to read and authorize, censor, or disapprove the publication of information supplied in the interview.

21. Open versus secret note-taking. There are times

when note-taking would defeat the purpose of the interview, and when it is better to remember as well as possible, and record later. Sometimes the interviewer resorts to playing with his pencil on a piece of scratch paper, making marks which appear to be meaningless but which help him to remember. In most cases, however, it is better to secure the full cooperation of the subject interviewed and then to take the notes openly. In fact, as a general rule, the more pronounced the note-taking procedure, the more important does the subject feel and the more willing he is to open up his heart and express himself.

22. Recording responses. Whenever possible, it is well to write down the statements in the speaker's own words at the time. The value of this, as suggested by Charters, is to "retain the flavor of the language and the exact terminology of the person interviewed." The written record should be so full and complete as to make unnecessary any later supplementing from memory. If only a few outstanding things are recorded and the rest added later from memory, there is considerable danger that the interviewer will read his own ideas and impressions into what he writes, and miss much of the real contribution. Naturally, shorthand is a help in this kind of work, but if complete stenographic reports are to be made, it is necessary to have a stenographer along so the interview's mind may be free to direct the discussion. Also the complete reports are usually so padded with unimportant material that the labor of using them is enormous.

23. Card systems. Either at the time of the interview or later it is well to record each point or idea upon a separate small card or slip of paper. A good plan is to assign each question a serial number and to

memorize this code thoroughly. Then each card can be identified by its appropriate number in the upper left hand corner at the time the point is written down. As many cards of a given number would be used as there were points, ideas, or contributions bearing on that question. Then later all cards of a given number from all interviews could be brought together conveniently for organization. If the notes are taken on larger papers during the interview they should be transcribed to cards as soon afterward as possible.

24. Organizing replies. If the replies are reduced to cards as just suggested, the task of organizing is extremely simple. It is best to wait until all replies to all interviews have been assembled before beginning to organize any of them, as it is useless to start crystallizing the material if more is to be added later. Also the write-up for one question will depend somewhat upon that for the others, and there will be problems of overlapping, conflicts, and establishing cross-connections. When ready to begin the actual arrangement of the material, the cards can simply be sorted into little piles according to their types, with illustrations and reasons bunched with the methods to which they apply, and these little bunches or piles may then be used as guides in the writing of actual paragraphs of the report.

25. Evaluating suggestions. The returns from interviews can seldom if ever be considered as strictly scientific. Whether one person's methods are better than another's is a matter for testing by some technique. The task of the interviews is to collect, assemble, and classify the various alternative methods and then turn the classified list over to the experimental scientist or the statistician, or the psychologist, to complete the

task of evaluation. The interviewer should, before doing this, however, take the trouble to make such interpretations of a common-sense or scientific nature as he can before leaving the job. Or, better still, he may at this point assume the role of the experimenter and carry his work on through the final stages. If this is impossible, however, it is better to have collected and classified a body of empirical or common-sense methods than to have left them only in the unrecorded experience of isolated practitioners.

26. Recording the interviews. The faith which the reader will put in a book which has been written from interview materials will depend upon how thoroughly the interviewer has done his work. Consequently, it is necessary to accompany the book by a record of the procedure and sources of data used. In other words, a record should be made at the time of the interview including the name, initials, title, address, occupation or position, specialty, etc., of the person interviewed, the date, place, and amount of time consumed in the interview, and any similar information which sheds any light on the thoroughness or system with which the study was pursued. If it is so desired, each person may be assigned a code number, which, when written in the upper right hand corner of each card, would identify the source of each of his contributions. This makes possible giving credit for the ideas without the labor of writing the name on dozens of cards. The final report should ordinarily bear a list of the persons interviewed simply as a means of expressing appreciation and giving credit for the courtesies shown.

EXERCISES AND QUESTIONS

1. How does the newspaper interview differ from the research interview? What procedures or policies do the two have in common?
2. What types of research problems require that interviews be conducted in disguise, and what types lend themselves to frank and unconcealed methods?
3. What are the advantages and the disadvantages of interviews conducted "spontaneously" and without the person interviewed knowing that he is being interviewed?
4. List the prerequisites of a successful interviewer.
5. List a number of educational research problems that are well suited to the use of interviews.
6. Read several treatments of the subject of interviewing and classify the types of interviews discussed.
7. How can the results of interviews be made to possess greater scientific value?
8. How does interviewing compare with other methods of getting information as to economy of time and effort? Expense? Richness of returns? Practical worth of returns? Scientific nature of returns? Personal development of the research worker?

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CHAPTER X

QUESTIONNAIRE TECHNIQUE

1. Limitations. According to some people, the most important piece of advice about questionnaire technique would be to avoid it entirely. It is quite true that it has been seriously and frequently abused, and that its use by untrained and uncritical workers has brought it into general disfavor. It should not be used as a lazy substitute for other methods, nor to collect facts that are available in print or in official records which are reasonably accessible. The proposed questionnaire should be clearly capable or producing the desired results or of actually solving the problem before being undertaken, and there should be no other possible way of getting the desired information. Ordinarily, a careful bibilographical survey and a thorough study of the problem by means of secondary sources would advance the investigator's knowledge to such a point that he would not need to send a questionnaire, but would instead narrow the question down somewhat, and solve it by more refined methods, such as are described in other chapters of this book. In the few instances in which this is not the case, and in which experimental, historical, statistical, and similar techniques are not possible, the following paragraphs may have some practical value.

2. Securing an adequate response. If the returns are to justify worth-while conclusions, they must be based upon a sufficient number of replies to give a high degree of reliability. Not only should the replies be numerous but also complete. That is, they should represent a

high *percentage* of response to the blanks sent out. The lower the percentage of replies the greater the danger that the answers are selective and therefore not representative of the total group of persons requested to answer. It is sometimes decidedly better to sacrifice numbers in order to gain a high percentage of response. This can be done by concentrating more energy upon a few representative persons and getting them all to respond, instead of using less pressure and applying it to more persons. There is always grave doubt attaching to the unanswered questionnaires, or to the unanswered items upon the questionnaire of a single individual, because the motive for failing to answer is simply a matter of conjecture. Silence may mean consent or its opposite. It may mean ignorance, prejudice, laziness, or many other things, and it is usually difficult for the instigator to learn which. For these reasons, it is extremely important to get a full response. The nature and merit of the questionnaire largely determines the adequacy of the response, hence the remaining paragraphs in this chapter are in part answers to the present problem.

3. Presenting the appeal. Whether a questionnaire is answered or put in the wastebasket depends largely upon the nature of the appeal that is made . There are several ways in which to increase the effectiveness of the appeal, as follows: (1) By means of the opening statements in the questionnaire. These should be of such a challenging and interesting nature as to sell the investigation and bring forth a response. (2) By means of an accompanying letter. Sometimes a special letter is prepared presenting in considerable detail the nature of the study, and the reasons why assistance is needed. (3) By writing in advance to secure a prom-

ise of assistance. This places the procedure on a much more dignified plane than simply sending the blank without warning, and in some cases has proved effective. (4) By letting each person know that he is one of a select list that is being asked to help. It is possible to make it clear that his expertness has been discovered, and to attach a certain amount of honor to answering the questions. (5) By multigraphing the questionnaires. Printed or mimeographed forms suggest large-scale operations, and cause each person who receives them to feel that his own response is of relatively small importance. But if the forms are multigraphed, and the person's address is typewritten with a type and ribbon selected to match the multigraphed copy exactly, the impression of a personal letter is secured, and a greater willingness to respond is thereby gained. (6) By presenting the appeal in person, rather than by mailing the blanks. It is often better to go around to the persons and give them the forms and ask their cooperation directly, where the purpose can be more adequately explained and emphasized by personal appeals. This gives the questionnaire much of the value of the interview. (7) By appealing to the person's interest in the advancement of science. If it can be shown that really valuable results will come from the study, no other reason is needed to enlist the cooperation of certain types of people. However, this is in some cases difficult to show. (8) By offering personal rewards. Chief among these is the promise of a copy of the returns. It is conceivable, however, that financial rewards for cooperation might be justified in certain cases.

4. Getting official support. The most successful use of the questionnaire is in those situations where replies

can be demanded by officials of some kind. Governmental authorities can get what facts they need by compelling answers. School principals or superintendents can get 100% replies from the teachers in their own schools, if they so desire. Teachers can get complete returns on questionnaires from their pupils, if they submit them as a regular classroom assignment. When the instigator has no such official relation to those from whom he desires information, it is sometimes possible to enlist the support of such an official person and work through him. Sometimes the forms may be sent out over the signature of such a cooperating official, or they may be accompanied by his letter of introduction. Again, such an official may simply distribute the blanks at a meeting of his subordinates, thereby signifying in an unofficial way that he is in sympathy with the study. The forms may, in other cases, be accompanied by a letter from the faculty member who is directing the research. In any case, a good rule is that no questionnaire should be sent out that has not previously received the approval of some person in authority who can judge its merit and suggest needed revisions. This would greatly reduce the number of foolish or useless questionnaires that discredit scientific work and workers.

5. **Time of sending.** There are two important factors that affect the time at which a questionnaire should be sent. The first is that it should not be sent at a time when other interests or responsibilities will interfere with it. If, for example, it arrives during a final examination week, its chances of being considered are greatly reduced. The other factor is that it should arrive at a time when the information desired is available. If it comes too early, there may be no informa-

tion available, or if too late the facts are not fresh in the mind and the answers will lack reliability.

6. Pre-tabulating the replies. The questions should not be sent out until the use to which the replies are to be put has been clearly determined. This means that the tables that are to be made should be decided upon, and the various columns and headings actually written down on paper beforehand. The investigator's own answers to the questions, real or imaginary, should then be recorded in the tables as a sort of rehearsal to be sure they are adapted to the replies. If the questions and tables are made together, the replies are not only more directly applicable, but also more economically handled when they come in. Unless this is done, the replies will ordinarily have to be edited or interpreted or classified before they can be tabulated, with consequent distortion of their original meaning.

7. Preliminary rehearsing. The interpretation placed upon a given question by those who answer it may be quite different from that of its author. If it is tried out on several people in a preliminary study, and they all understand it correctly, it may be considered as safe, but if a few of them misunderstand it or answer it from a different viewpoint than that intended, revisions are needed. To make up a tentative form and try it out and revise it before distributing it generally is expensive, and sometimes hard on the investigator's patience, but the care is amply repaid in improved results.

8. Number of questions. The short questionnaire is much more likely to be answered than the long one. Furthermore, each item in it is more likely to be answered carefully. It is better to have a few highly significant questions than many trivial ones. As a

general rule, a little extra time and effort will reveal possibilities of omissions and combinations which will greatly improve the results. There is an exception to this rule, possibly, in the case of official questionnaires, where answers to long ones can be required as well as short ones, but even here the mental attitude produced by a burdensome list of questions may be so bad as to reduce the quality of the answers.

9. Classification schemes. Questionnaires fall into two general types in regard to the schemes of classification of the material in the answers. One type calls for the answers according to the system of thought of the respondent, letting him write freely according to his own natural associative processes. The investigator then rearranges the information to fit his own scheme of thinking, putting the various points or facts into such places in the classification scheme as seem to be most suitable. The other type forces the respondent to fit his answers into the predetermined moulds or classifications of the investigator. In this type, the field is divided up into such sections or parts as the investigator sees fit, and this classification is imposed upon all those who answer. The advantage of the former type is that it does not hamper the respondent by forcing him to fit his ideas into a scheme of thought that runs "against the grain" of his own thinking. On the other hand, it imposes upon the investigator an almost hopeless task of making the necessary adjustments from the various classification schemes to his own, and results in a certain amount of distortion of the various persons' answers when he reclassifies them. Unless there is some very good reason for doing otherwise, the questionnaire should be arranged according to the second type.

10. Ambiguity. There are two types of ambiguity which interfere with questionnaire studies. The first is ambiguity of questions. Unless the questions are very carefully stated, and then checked by rehearsal with a preliminary group, they are likely to mean different things to different persons, producing incomparable and misleading replies. Terms should be defined exactly, and in cases where there could be any doubt the use of one or more synonyms in the question should be resorted to. The questions should be so worded as to be understood by the least intelligent person who is to answer them, and should be so clear to all respondents that all effort will be expended in answering them, rather than in interpreting them. In so far as the questionnaire is an intelligence test, it defeats its purpose. The second type of ambiguity that interferes with questionnaires is ambiguity of answers. Not only must the author's meaning be clear to the respondent, but the respondent's meaning must be clear to the author when he attempts to use the replies. The questions must be so worded as to call forth answers of a type which cannot be misunderstood by the person who is to use them.

11. Objective answers. An excellent device which serves a number of different purposes in improving questionnaire studies is the use of objective answers, or short answers with unmistakable meanings. There are several types of these: (1) The "yes or no" answers, such as, "Do you give school credit for home work?" (2) The quantitative answer, such as, "What percent of grade on an examination paper do you base on the use of English?" (3) The check answer, wherein all possible answers are listed on the sheet and the respondent checks those to which he subscribes.

(4) The rating answer, wherein each of several items is judged to be "much, little, or none" etc. (5) The ranking answer, in which the several items listed are to be ranked according to the judgment of the respondent. (6) The test answer, wherein the questionnaire is administered as an ordinary new-type test, in which the person answering is eager to make a good score. An illustration of this is the use of such a true-false test as "Radicals who commit crimes should be executed without trial," instead of "What is your attitude toward the treatment of radical criminals?"

12 Factual questions. The value of a questionnaire is increased if the questions asked are of a factual nature. Questions calling for judgment or opinion are ordinarily of minor value. The use of the questionnaire by workers in the early child study movement has been seriously criticized because of the emphasis placed upon impressions or generalizations about child nature rather than upon actual cases of child behavior. If the questions bring forth a large number of specific facts or incidents or cases, the investigator can generalize upon them by the aid of scientific or statistical techniques, but if the persons who answer the questions report their own unscientific generalizations, the investigator can hardly deal with them in a scientific way.

13. The resort to memory. To rely upon the memory of the person who is to furnish an answer reduces the value of the study. This is especially true when the events to be reported by adults are remembered from childhood. As time passes, memory becomes mixed with imagination, and it is almost impossible to separate fact from fiction. It is better to ask for facts concerning events as they happen than

after they have happened, unless, as is sometimes the case, the questionnaire is to be answered later from records that were actually made at the time of the events. For instance, if the purpose of the study were to determine the daily activities of a group of students for a week, it would be safer to have them keep their records daily than to have them write up the whole week's activities at the close of the period.

14. Impossible questions.. The usual questionnaire prepared by untrained investigators contains one or more questions which could not possibly be answered by the persons to whom it is sent. Such questions are either discarded in disgust, or else answered by guessing, which leads to false conclusions. There are two ways of overcoming this difficulty: (1) Send questions only to persons who are known to possess the information or to be able to secure it from reliable and convenient sources. (2) Limit the questions to the kind of information known to be in the possession of the persons who are called upon.

15. Leading questions. The makers of questionnaires may learn a valuable lesson from the courts, in that leading questions distort the truth. Human nature is such that suggestion plays a strong part in determining the answers to questions. The way a question is asked has much to do with the answer received. If the investigator has a bias, he must be careful not to show it, else he will get a larger number of answers from persons who share his bias, and this will influence the kind of answers received from persons who are actually neutral.

16. Anonymous replies. Sometimes the chief problem in a questionnaire study is to get replies which are truthful. Questions calling for personal informa-

tion that might be embarrassing are of doubtful value unless they are answered anonymously. Students who are asked to report their study practices or their reactions to courses are seldom content with the assurance that their grades will not be influenced by the answers. Even leaving off names is not always enough since there is a fear that the teacher will recognize the handwriting. On the other hand, there are situations in which better replies are given when names are attached. Students who hide behind anonymous replies to be smart and clever are more likely to take the task seriously if obliged to sign their names. Also the names enable the investigator to correlate the returns with information from other sources, as intelligence tests, school grades, etc.

17. Spatial arrangement. The physical arrangement of the questions on the page is of some importance. Merely providing a line or a hollow square or parentheses for the answer makes it possible to get all answers uniformly arranged, and thus aids tabulation. The arrangement also has something to do with the omission or overlooking of questions. Also the amount of space allowed for answers influences the kind of answers received. For example, if short objective answers or strictly categorical yes or no answers are desired, it is well to crowd the questions so that no room is allowed to write long qualifying statements. On the other hand, if a question calls for a long statement, but has only a small space, a good opportunity has been lost. A large space encourages a long answer, and a short space the opposite, even though the directions state that supplementary sheets may be used if necessary.

EXERCISES AND QUESTIONS

1. Why is the questionnaire in such general disrepute as a research device? How may this situation be improved?
2. Under what circumstances is the resort to the questionnaire desirable? When not?
3. Make a list of problems which seem to require the use of the questionnaire. Examine each to see if some other method of attack would be feasable.
4. Actually draft a questionnaire for use with one of the problems listed in the previous exercise, and submit it for criticism.
5. Prepare a brief questionnaire to be answered by your fellow students. Check up the results and see how many of the questions actually achieved their purpose.
6. Examine the questionnaires in one or more research reports and criticize each as to its merits and demerits.
7. Read the discussion for and against the use of the questionnaire and formulate what you consider a tenable position regarding it.
8. Classify questionnaires according to their types. According to the purposes which they are to serve.

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CHAPTER XI

OBSERVATION TECHNIQUE

1. Active versus passive observation. The process of scientific observation is quite different from merely "looking around." It involves a *study* procedure rather than a mere visiting procedure. It requires methodical and painstaking work rather than a mere tickling of the senses. It is often necessary to continue a task for a considerable time after it has ceased to be interesting. The procedure which yields the greatest return in interest or satisfaction, or even in valuable personal experience to the observer, is not necessarily the one which will make the greatest contribution to educational science.

2. Number of specimens. Since uniformity of specimens is almost never to be found in educational phenomena, observations must be made upon a number of different cases in order to discover what is typical. Observations upon several school buildings, several English classes, or several instances of misconduct will yield considerably richer data than observations upon only one case. As a rough working rule, it is fairly safe to say that by the time thirty specimens of a given type have been observed, the additional ones cease to contribute an appreciable number of new elements. By comparing the records of the various observations, however, it is comparatively easy to discover when the point of diminishing returns has been reached to such an extent as to make further observations unprofitable. If the various specimens which are observed are compared one with another, the individual traits of each and the universal traits

of all will be more readily discovered, thus leading to more helpful generalizations. Probably scientific observations more often suffer from the comparison of an insufficient number of specimens than from too many.

3. Sampling. The time and labor involved in observation make it impossible to observe all specimens or cases of a given phenomenon; consequently it is necessary to resort to sampling. It is better to select a few typical cases for careful and thorough observation than to make superficial observations of a large number. The important essential, here as elsewhere, is that the cases chosen should be *representative* of all the cases from which they are selected. If they are selected in a haphazard way or according to the whim of the observer, they may yield an entirely false impression of the facts. For instance, if the best schools, teachers, or pupils are chosen, the results are misleading in one way, and if the worst ones are chosen the error is in the other direction.

4. Repeated observations. There is much to be gained from observing the same specimen more than once. A second look is almost certain to reveal things not seen the first time. The first time may be a special case, an "off day" possibly—but several repetitions will undoubtedly yield a more reliable impression. Supervisors have learned that it is unwise to base their estimates of a teacher's efficiency upon one visit to her classroom. Furthermore, there is a limit to what can be seen and appreciated at one time, somewhat as there is a limit to the amount that can be eaten at one meal. To observe and go away to study over the notes taken in order to "digest" the experiences gained makes it possible to return with

a number of new questions, or with a renewed appetite for knowledge. It should be kept in mind, however, that later observations depend for their value upon their progressive nature. That is, each should be built upon the results of the previous ones, so that the whole series is cumulative.

5. Duration. Hasty observations are likely to miss the big things. The true scientist considers his time of no value so long as there is chance of out-waiting a phenomenon and thus forcing it to come out into the open where it can be seen. Numbers of conclusions in science have been proven false because of factors which developed after the close of the observation period. For example, a very short period for the observation of a patient who has been administered a stimulant might create the impression that he is rapidly recovering, but a longer period would reveal quite the opposite. Similarly, educational experiments which are yet in their youth are sometimes misjudged because of the lack of time for all aspects to reveal themselves. Watson has called attention to the need of continuous observation of infants from the hour of the birth on as the only sure way to discover what forms of behavior are really instinctive and what forms are learned through experience.

6. Previous preparation. It takes time and serious study to get ready for scientific observation of a phenomenon. It is necessary to know the general field through and through in order to know what to look for. The more one knows before the observation, the more he is likely to learn during it. Professional reading on the subject of school buildings or methods of teaching is essential as a preparation for visits to school plants or classroom recitations. This reading

and study might well look toward the following objectives. (1) Mastery of the general technique of observation, as formulated in the books on observation of teaching. (2) Discovery of the standards of merit which are to be used in judging the particular phenonenon or thing to be observed. (3) Planning a campaign or schedule of procedure to be followed in the actual observation.

7. Observation guides. The use of a list of points to look for makes it possible to learn more about what is observed. Unless certain definite objectives are kept in mind, it is entirely possible for more interesting but unimportant matters to crowd the real essentials out of the attention. It is not uncommon for irrelevant events adjacent to or concurrent with the things being observed to gain more attention from the observer than the thing itself. A written or printed list of items to be rated or recorded, or a blank form to be filled in with the results of the observation will usually more than repay the effort required to make it.

8. Some things to look for. What to look for naturally varies according to the problem, but some idea of the infinite possibilities that are before the observer may be gained from the following suggested list of items: (1) The objects involved, as glass, wood, people, paper, etc. (2) The attributes or qualities of these things, as blue, hard, tall, etc. (3) The actions involved. (4) The locations or spatial relations of the things. (5) The duration, or time, of the events. (6) The functions or purposes of the various items. (7) The factors responsible for the phenomena or events. (8) The cost. (9) How they work. (10) The environment or setting in which they are located. (11) The probable future or outcome of events. (12) The

classification schemes into which they fall. (13) Differences between the various specimens. (14) Differences between these and previously observed cases. (15) Facts not obsrved before. (16) Inferences from what is observed, as to their significance for other facts.

9. Objectivity. A little time spent in translating subjective matters into objective form that can be definitely formulated and recorded adds enormously to the scientific value of observations. It is well to make conscious effort beforehand to list the tangible or objective items in the given situation which lend themselves to observation. For example, "Teacher domination of the recitation" is a mere matter of subjective judgment or estimate until a little study suggests the use of a stop watch to record the portion of the hour during which the teacher talks and the portion during which the children talk. Similar devices may be employed on other types of observation with similar improvement in the results.

10. Instruments of precision. It has long been known that there are rays of light which can not be seen by human eyes, and sounds that are of too high or too low pitch to be recorded by human ears. Similarly, there are objects too small or too far away to be seen without the aid of microscopes or telescopes. For many purposes, therefore, it is necessary to use mechanical extensions or supplements to the sense organs in order to improve observations. Sometimes the unaided senses may be useful in exploring the field and in locating problems, after which instruments are needed to study them in detail. In some cases the necessary instruments are already available, but in other cases the scientist must invent or devise them

especially for his purpose, as was done in the case of the machine for photographing eye movements in reading. The stop watch, the motion picture machine, the ordinary camera, the X-rays, the use of films sensitive to ultra-violet or infra-red rays, the tonoscope, the microscope, the thermometer, standardized tests, etc., are illustrations of instruments that have been useful in making observations of educational phenomena. It should be said, however, that too much precision is as bad as too little. Some things can not be observed as well through the microscope as through the naked eye because of the details obscuring the main features.

11. Measurements. Measurement is simply a refined form of observation. It attempts not simply to determine the presence or absence of a phenomenon or practice, but also its degree or extent. It seeks not for a "yes or no" answer but for an answer to the question "how much." If observations are reduced to quantitative or numerical terms, they become more precise and lend themselves to more refined statistical treatment. It is almost always preferable to summarize the results in numbers rather than in adjectives. Many facts are more adequately studied by the use of objective tests than by mere subjective estimates. For example, if it is desired to learn how well students have learned library technique it may be better to give a true-false test made up of such items as the "The Readers' Guide is an index to periodical literatrue" than to spend several days watching students work in the library. This does not mean that subjective estimates should never be employed, but rather that they should be used only to supplement the use of improved forms of measurements.

12. Experimental control. It is sometimes necessary to provide special laboratory conditions where a phenomenon may be observed under more favorable and more carefully controlled conditions. For example, the horses of Elberfeld were observed to do such remarkable things as answering questions in several different languages or computing difficult problems in mathematics, and apparently possessed most unusual intelligence. But when the psychologists took the trouble to control the conditions incident to these unusual performances, they discovered that the horses were getting signals from persons in the audience and that their supposed intelligence did not exist. If a phenomenon can be observed under conditions which free it from irrelevant and confusing factors, or if it can be observed, the conditions varied, and then observed again to note the change, the truth is more likely to be discovered. Sometimes the setting is more important than the thing itself, and if the setting can not be controlled, it is impossible to know how much to attribute to it. Again, it is important sometimes to be sure that the setting remains constant throughout the period of observation, else a shifting of conditions may be confused with the phenomenon itself. In short, observation is best performed in the experimental laboratory.

13. Typical conditions. A caution is needed at this point lest the last paragraph leave a wrong impression. In the effort to control conditions for observation, care is necessary to avoid creating an artificial or unnatural situation that is not typical of ordinary life conditions. For example, a child's reading when his head is strapped into position for his eye movements to be photographed may not be entirely the same as when

he is reading a story for his own amusement. The mere presence of the observer in a classroom may distract the attention of the pupils or make the teacher nervous. The nature of the thing to be observed has much to do with whether to set up controlled laboratory conditions or to go and see it in its natural setting, but whichever method is used, it is important that an unnatural situation should be avoided as much as possible.

14. Abnormal cases. The average man knows more about automobiles from what he has picked up when they were broken down or functioning badly than from his experience with them when going smoothly. The abnormal cases in educational affairs may shed considerable light on the normal case. The science of medicine owes much to what has been revealed by disease, and psychology owes much to abnormal psychology. Frequently the abnormal case is not essentially different from the normal, being simply an unusually emphatic form which thereby attracts attention. The point is not that we should devote all or even a major part of our energies to problem children or abnormal cases, but rather that we should go to these for the light which they may shed on the whole situation.

15. Records. The major value of observations is lost unless suitable records are made. The principal points to be considered in this connection are as follows. (1) The records should be complete and detailed, not vague generalities or mere impressions. (2) They should ordinarily be made upon previously prepared blanks, tables, charts, or forms, with a regular place for each item to be recorded. (3) In most cases the records should be made at the time of

the observations, while the impressions are vividly stamped upon the senses, although there are situations in which the writing of notes would interfere with observation or possibly with the normal behavior of the process being observed. In this case the records should be made immediately after the close of the observation. (4) In some cases it is better to be receptive to what is shown rather than to take the initiative in trying to discover things. For example, the guide that shows a group through a factory probably has a better prepared plan for the excursion than the guests who are going through. In such a case, it may be better to take the information in the form in which it is supplied and to organize the impressions later according to the plans for the particular study. (5) The recording of observations is not only to be used for the sake of the resulting record, but also as an aid to the observation itself. To draw what is seen, or to describe it in writing, directs attention to the essentials and enables the eye to grasp more of what is before it. Each attempt to draw or to describe improves the succeeding effort to observe. (6) Such papers, materials, samples, or parts of the thing observed as can be carried away feasibly should be made a part of the record. These include photographs, souvenirs, printed schedules, bulletins, mimeographed lesson materials, lists of articles used, specimens of student work, etc. Such articles give reality to the records and enable the analysis of the situation to continue after the close of the observation period proper.

16. Later study. Just as reading beforehand about the thing to be observed enriches the ensuing observation, so does reading about it afterwards add to the

interpretation of the impressions gained. Teacher-training institutions have learned that the value of classroom observations is greatly increased if there are follow-up lessons and group conferences based on them. An alternation of study and observation periods seems to be the most effective arrangement for discovering the full meaning of the things observed.

17. Supplementary methods. Observations yield richer returns when combined with other supplementary techniques. For example, the interview will produce many items of information which mere observation alone will not give, as in the case of having a talk with a teacher about her classroom technique before or after observing a recitation. The values of the experimental method, and of measurement as aids to observation, have already been mentioned. The historical technique is sometimes important, since the previous history of the thing observed is essential to its effective interpretation. Statistical techniques are needed to treat the results of the observations. The case study technique has its special contributions, as does also the method of introspection, or observing one's own behavior, in certain cases.

18. Ethics and diplomacy. There are several little matters which an investigator using the observation technique may well keep in mind to preserve the right state of mind on the part of those with whom he has personal relations. Some of these are as follows: (1) Be careful not to disrupt the classroom work because of the observation. One good way to avoid this is to enter the room before a class begins and remain until after it ends. (2) Do not manifest approval or disapproval of what is seen, lest this cause a change in the procedure or create an undesirable state of mind

on the part of the persons involved. (3) Make a good impression upon the persons concerned so that a way will be left open for later observations. (4) Refrain from telling the parties observed how others perform the operation. The purpose of observations is learning and not teaching. New ideas should always be welcomed by the observer, but not imparted by him to the persons observed. (5) In some cases note-taking should be reduced to a minimum or postponed entirely until after the observation is completed, lest it produce the wrong effect upon the persons observed. It is well to take a position from which the notes which are written can not be read by the persons whose reactions are described, in order to get greater freedom to write down the facts without restraint. (6) Do not tell tales about the person observed, even if they are true. The observer is the guest of those observed, and to make remarks about the host after partaking of his hospitality is obviously unkind.

EXERCISES AND QUESTIONS

1. How important or valuable do you consider observation as a research technique? Why?
2. Wherein is observation superior to interviews and questionnaires? Wherein inferior?
3. How can ability to observe be improved?
4. In what sense is observation an essential part of every scientific investigation?
5. List a number of research problems of your own school which lend themselves well to the use of the observation technique?
6. Prepare a list of elements to look for in connection with one of the problems mentioned above.
7. What are the essentials of successful scientific observation?
8. Explain why more research workers do not resort to visitation and observation instead of sending out questionnaires.

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CHAPTER XII

MEASUREMENT TECHNIQUE

1. Providing a measurement situation. Measuring is more than simply giving tests. It frequently happens that the main task is to prepare such a situation or lay such a foundation that the tests when given will tell what it is desired to know. For instance, if the problem is to measure the results of a year's work in arithmetic, it is necessary to prepare for the final measurement by giving a test at the beginning of the year to serve as a basis for comparison. An enormous amount of waste takes place annually in the schools because of indiscriminate giving of tests which by the very nature of the situation could not yield very useful knowledge. Sometimes an experimental procedure is necessary as a preparation for the measurement. In short, measurement serves its highest purpose when it is used as a tool in connection with some other type of research procedure rather than as a thing in itself or standing alone.

2. Time of measuring. There are two common policies employed in measuring the results of research projects, one the immediate, and the other the more remote. For example, a test may be given at the conclusion of each lesson or study period to measure directly the fruits of that particular unit of work, or a whole series of lessons may be taught without any testing and the whole measured by a test at the end. The advantage of the more remote type of measurement is that it records the changes or results which

are of a more permanent nature and ignores those that do not last long after the original exposure. The disadvantage of the remote measurement is that it measures the ability in question after it has become mixed up with the results of hundreds or thousands of other experiences acquired both in and out of school. In other words, the longer the time before the measurement the more the quality or ability measured becomes diluted by the addition of other qualities or abilities. If it is such an ability as calls for extremely delicate or precise measurement, it is frequently impossible to measure it except in its more concentrated form, that is, immediately after it has come into existence.

3. **Sampling.** A good rule to follow is to measure comprehensively; that is, to measure a rather large sampling or the whole rather than a small portion of it. For ordinary purposes it is easier to estimate a fairly large unit of a given ability than a very small one. For example, it may be easier to judge a student's collateral reading results by the term paper he prepares after weeks of work than by the test on one day's reading. When the unit of sampling measured is microscopic, the measuring instrument must be very precise, more precise than yet exist in most types of educational work. Not only does the larger sampling eliminate the seriousness of small errors in the measurement, but it also increases the chances of being truly representative of the total range of abilities sampled. An examination consisting of ten questions is much more desirable than one which includes only two, but not so good as one of fifty or a hundred.

4. **Many-sided measurement.** To measure only the length of a room and ignore its height and width is no more serious an error than to measure educational

products by one kind of test and ignore the other phases which it does not take into account. A new-type test may reveal certain things not shown by the older essay-type test. A standardized test might show still different things. One plan of scoring may not take into account the elements which are recognized by a different one, as in the case of scoring arithmetic tests for correctness of principle and for correctness of answer, respectively. A one-sided measurement of results of an experiment may reveal startling growth in a certain ability when a more complete or all-round measuring program would show this to be accomplished at the price of a great loss in some other ability which had previously been left unmeasured. A safe rule to employ is that of using several different kinds of tests, and those of as widely different types as possible.

5. **Measurement by analogy.** Measurements of abilities in terms of normal experience are preferable to measurements in terms of abstractions from that experience. For example, business ability is better measured by achievement in business than by tests in arithmetic or bookkeeping. Likewise, ability to swim is better measured in the water than in a laboratory where measurements are made of chest expansion or strength of the muscles. There is a constant temptation to resort to measuring by analogy, that is, measuring something that seems to be similar to the desired ability but which is more tangible or more easily measured, and then to let this measurement take the place of the genuine one. Probably the most common variety of this is measuring verbal or linguistic behavior and letting it stand for behavior in general. What one *says* are his attitudes may not be at all representative of his real attitudes, either

because he is dishonest or self-deceived. Again, a person may be quite skillful in a given operation and lack linguistic ability to make a passing grade in a verbal test upon it, while others can tell how to do it remarkably well but are unable to do it themselves at all. If measurement by analogy is employed, it is extremely important that the analogy actually hold true throughout.

6. Selecting available tests. The number and variety of measuring instruments for educational work has so greatly increased in recent years that it is difficult to know what is the best tool for a given situation or need. The careful scientist will find it necessary to make considerable study simply of the various tests, scales, score cards, and instruments of precision that others have devised, in order to be able to make an intelligent choice. A course in tests and measurements should be a part of the preparation of the research worker so that he can make more intelligent selections of the tests to use. Lacking such a training, the least he can do is to secure the descriptive catalogs of tests published by the three leading publishers and study them carefully to familiarize himself with the available supply.*

7. Devising new tests. Many research problems in education call for tools not yet invented. The investigator must stop and create a test or measuring instrument for a specific purpose. The making of tests is a large field which cannot be entered here, and which should be studied by means of regular books

*These publishers are:

(1) World Book Co., Yonkers-on-Hudson, N. Y.
(2) Public School Publishing Co., Bloomington, Ill.
(3) Bureau of Publications, Teachers College, Columbia University, New York, N. Y.

and courses on the subject. The practical research worker, however, may find the making of a home-made test somewhat easier if he will become familiar with those already in existence. A thorough study of these, coupled with a close analysis of the particular problem, should result in suggestions for a new instrument to meet the needs.

8. Determining the value of tests. An important research problem in the field of measurement is that of evaluating tests to see how well they actually measure and comparing the relative merits of two or more different tests. The chief essential for such work is a known criterion against which to compare the test scores. This is often exceedingly difficult to obtain. The following suggested procedure attempts to overcome this difficulty. The steps or elements are as follows: (1) The basic consideration is that the situation is to be controlled, by experimental means if necessary, so that it is known beyond a doubt that there is a difference between two groups in the trait or ability to be measured. For example, one class of students may be taught a series of lessons on the civil war and another not exposed at all to that instruction, thus making certain that there is a real difference before applying tests which are to measure it; or one class may be given thirty minutes to study a lesson while the other class is allowed only five minutes to form a rough acquaintance with it before the tests are to be administered. For convenience those who are known to possess the desired ability will be called "sheep" and those who are known not to have that knowledge will be called "goats." The merit of a test will then be judged by how well it separates the sheep from the goats. (2) Having provided two con-

trasted groups, the next step is to administer to each group the test or tests to be evaluated. If the problem were to see how well a completion test measured, it would be given to both groups and the scores compared to see how many of the goats were able to get in with the sheep, or in other words, how much overlapping of scores existed. Or if the problem were to see whether the completion test measured better than the true-false test, they would both be given to both groups and the overlapping of the sheep and goat scores on one test compared with the overlapping of scores for the same two groups on the other test. If, for example, 40% of the goats got scores higher than the poorest sheep on the true-false test, but only 10% did so on the completion test, we should say the completion test was a better measuring instrument because it detected the known difference between the two groups more thoroughly. (3) The amount of overlapping of the scores for sheep and goats on the tests may be determined with accuracy by any of several methods. The frequency curves for each group may be drawn and the overlapping observed graphically. The number of goats exceeding the lower quartile, median, or ten percentile for sheep may be determined, or the mean scores of the goats may be subtracted from that of the sheep, and the reliability of this difference computed by getting the experimental coefficient. The experimental coefficient for the completion test may then be compared with that for the true-false test, the larger coefficient indicating the better test. (4) In cases where experimental control is impossible, resort may be made to selection of extremes that are obviously far apart in ability as a means of providing the sheep and goat groups. For example, one group

may be made up of "A" students and another of failing students. Or if the tests to be evaluated are tests of character traits, a normal group (sheep) may be compared with a group of delinquents (goats) in a special institution.*

9. Precision. A test should measure with that degree of precision which is appropriate to the product measured. Areas of counties are measured in square miles and not in square inches, but precious stones are measured in carats rather than in pounds. Number is the greatest contributor to precision. Measurements that result only in adjectives, as "large," "good" or "valuable," are ordinarily far from precise. A test should yield numerical scores, and these in small enough units to produce a sufficient spreading out or distribution of the cases measured to enable them to be handled readily. Thus a test which only sorts the students into two classes, "pass" and "fail," leaves too many people together with the same score, while a five-grade system distributes them more. A test should be so easy that no one fails to do something on it, and so difficult that no one makes a perfect score, and should result in a sufficiently large range of distribution to make the cases stand out fairly well from one another.

10. Diagnostic tests. To know a child's total score on an arithmetic test is of some importance, but to know separately his scores on each of the processes,

*For further details and examples of this technique see:

(1) Crawford, C. C. and Raynaldo, D. "Some Experimental Comparisons of True-False Tests and Traditional Examinations"; in *School Review*, Vol. XXXIII, Nov. 1925; 698-706.

(2) Crawford, C. C. "Of What Value are True-False Tests"; *Educational Research Bulletin* of the Los Angeles City Schools, Vol. VI, Feb. 1927; 3-6.

as addition, subtraction, etc., is much more important. The idea of a diagnostic test is to get such analytical results, or to discover the nature as well as the amount of the abilities studied. The research worker should be encouraged to use this type of measurement more, even if he wishes to combine the parts and get a composite score. The old saying, "you can't unscramble eggs," suggests that it is better to make separate records for the various parts of a test, and later combine these, than to attempt to analyze later what has been measured or recorded only in composite form.

11. Uniform gradations. If scores on a test are to have maximum value, the units should be of the same size at all points in the scale. Such is seldom the case. For example, the difference between a grade of 25% and 35% on a test is of small importance as compared with that between 65% and 75%. Likewise, a gain of 10 words a minute in typewriting in the first month of practice is not the same as 10 words gained after reaching a speed of 100 words per minute, because progress in the early period is easier to make. Educational products should be measured in a manner comparable to the measurement of gases, taking great care that measurements be made under uniform degrees of density or pressure. The experimenter must beware of comparing the improvement made by advanced students with that made by beginners, since the advanced students may be very close to the limit of possibility, requiring greater effort to produce equal results. The device for transmuting test scores into units which are equal at all points in the range is called "scaling." There are various methods of doing this, among the most common of which is the T-score

method. These are described in the books on tests and measurements.

12. Directions. There are two major essentials of good directions for a test. The first is that they should be clear enough to permit those taking the test to devote their attention to taking it rather than to finding out how to take it. Incomplete or indefinite directions may make the test a measure of intelligence or previous experience with tests rather than of the ability which it is desired to measure. The other essential is that the directions should cause all persons to react to the test in the same or uniform way. They must be understood alike by all candidates, else the results are not comparable. Also the directions must equalize speed, interest, etc., on the part of the candidates so that one will not work at a furious pace while another proceeds in a leisurely way. McCall suggests that it is better to equalize such things by having all work at maximum rather than at average pace. For example, he would have them all work "as rapidly as you can" instead of "at your usual rate."

13. Validity. A test is valid when it actually measures what it pretends to measure. There is constant need for examining the tests used upon this point. Many elaborate investigations have been proved worthless because it was found later that the tests used were not valid. For example, the aim may be to measure knowledge when in reality the main thing measured is speed, or ability to write good English, or ability to use the teachers pet terminology, etc. A certain person of unquestioned ability made a score on an intelligence test that indicated feeble-mindedness, simply because his past training had emphasized extreme carefulness and double-checking his work for

accuracy. His low score was, therefore, not vaild because it was due to carefulness rather than low intelligence.

14. Reliability. A test is reliable if it yields the same result every time it is given. If, however, a given pupil's score is high at one time and low at another when the ability measured remains constant, the test would be classed as unreliable. There are two things which the research worker who uses tests should do about reliability. (1) He should determine how reliable his tests actually are. This may be done by several methods. One is to correlate the score on the even items with those on the odd. Another is to give the test twice and correlate the resulting scores. Or, if he wishes, he may compute the reliability coefficient by statistical methods. (2) He should increase the reliability of his tests. This may be done by making it longer, as a large sampling yields more stable results than a small one. A test of 100 items is more reliable than one of 50 items. Giving the test more times, or giving it to more persons, also increases reliability.

15. Standards. In olden days it is said that a "foot" meant the length of the foot of the king or chief, and would therefore vary from time to time and from country to country. The units for most educational measurements are not even that well standardized. A child's intelligence or knowledge of a subject is still measured by comparison with some imaginary standard in the teacher's mind which fluctuates over a wide range even in the course of grading a single set of papers. The remedy for this is standardization, or the development of norms. Specimens of work or achievement may be set up as standards and all work

compared with these, as in the case of the handwriting scale, or a test may be given to large numbers of children, their scores computed, and these results used as a standard with which to compare individual cases. The research worker finds it very advantageous to use tests or scales which have previously-established norms wherever possible, and, in the absence of such a situation, he sometimes has to use the average of his own group as a temporary or tentative norm.

16. Objectivity. A measurement is said to be objective if it may be made by different people without changing the results. In other words, it should not depend on personal opinion of the investigator. The new-type test is more objective than the former essay type. Standard tests are more objective than teachers' judgments. The research worker should study carefully the recently developed literature on the objective or new-type examination to familiarize himself with the multitude of practical devices for measuring in objective ways things which have for so long been considered as mere matters of subjective judgment.*

17. Subjective judgments. Since perfect objectivity is so often impossible to gain, resort must constantly be made to estimates and ratings of a subjective nature. To discard such forms of measurement at the

*A few of these books are as follows:

(1) Paterson, D. G., *Preparation and Use of New-Type Examinations*, World Book Co., Yonkers, N. Y.
(2) Ruch, G. M., *Improvement of the Written Examination*, Scott, Foresman & Co., Chicago.
(3) Russell, Chas., *Classroom Tests*, Ginn & Co., Boston.
(4) Ruch, G. M., and others, *Objective Examination Methods in the Social Studies*, Scott, Foresman & Co., Chicago.
(5) Weideman, C. C., *How to Construct the True-False Examination*. Teachers College, Columbia University, N. Y.

present stage in the development of educational science would be folly. The following methods, devices, and suggestions may help to improve the quality of this type of measurement: (1) Analysis into smaller units. When a complex object, process, or ability is broken up into sufficiently small divisions, each division can be judged with a high degree of precision. This is done by expert stock or poultry judges, who score a single part of the animal at a time instead of the whole animal at once. (2) Use of rating scales and score cards. For many educational purposes, scales and score cards are already available. They consist of lists of qualities to be judged, and sometimes also involve some kind of suggested weights for each, such as distributing 100 possible points among eight or ten different qualities. (3) Ranking. Where there are several persons, objects, or specimens to be judged, simply arranging them in the order of merit is sometimes a quite definite and satisfactory form of measurement. (4) Comparing all cases with one or more cases which have been taken as standards. An example of this method is a study that involved rating the value of school subjects by comparing them with English, which was given a value of 10 points arbitrarily to serve as a starting point. (5) Practicing the making of the particular type of judgments. Persons who first begin judging handwriting by a regular handwriting scale find that it involves an element of guessing at first but that, as more cases are scored, the judgments become more refined and the results more reliable. Comparison of one's own ratings at different times facilitates this improvement. (6) Making several different estimates of the same thing. Several independent observations and ratings of an object are more likely to

average the true result than is one single rating. (7) Having several persons make judgments. The concensus of several persons' judgment is more reliable than a single person's judgment, provided that the judges are all competent, since personal prejudices may be supposed to neutralize each other somewhat. (8) Using code numbers or other devices to eliminate personal prejudice. Sometimes it is impossible to compare two sets of student papers fairly unless they are freed from all trace of their group membership by the use of some sort of key numbers until after the ratings have been made. (9) Having persons do the judging who are not familiar with the object of the study. The experimenter may be unable to compare the two groups fairly but an outsider who did not know what the experimental variables were would have no such prejudices.

18. **Treatment of results.** Measurement is not an end in itself. It is simply a means to some other worth-while end. The value of the most careful and painstaking measurements imaginable may be nullified by crude or improper statistical treatment of the results. There is as great need for precise ways of treating data secured from measurement as for precise measurements themselves. The scores tell nothing in themselves. They have to be treated in such a way as to cause them to tell their story. For this reason the present chapter should be supplemented by further study about statistical technique.

EXERCISES AND QUESTIONS

1. Show how measurement is necessarily a feature of all research.
2. Criticize the statement that the science of education is due largely to the measurement movement.
3. What are the essential requirements of a good measuring instrument?
4. Distinguish between research *upon* tests and research *by means of* tests.
5. Make a list of research problems *upon* tests which would be of especial benefit to your school, and indicate how you would attack each.
6. Do a similar thing for research problems to be attacked *by means of* tests.
7. Read and criticize a number of measurement investigations as to their technique.
8. What difference in knowledge of measurement technique would you think there should be between the research worker and the classroom teacher who uses tests? Why?

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CHAPTER XIII

STATISTICAL TECHNIQUE

1. The statistical viewpoint. Statistical processes and methods are used in such a wide variety of situations that a single statement of the nature of the statistical viewpoint is difficult to make. The following points will shed some light upon it, however: (1) It is quantitative. Facts must be stated in numerical form in order to be treated statistically. (2) It is founded upon the concept of individual differences. It is of little importance in chemistry or physics because a given object or chemical element behaves the same as all others of its class. But biological, psychological, and sociological phenomena do not possess such uniformity and therefore necessitate special technique for discovering the general trend running through a number of widely varying individual cases. (3) It takes things as they are and classifies them to make them yield desired information, whereas the experimental method employs the artificial control of things to discover the truth about them. Consequently, the statistical method is especially good as a substitute for the experimental method on such problems as do not permit of controlled conditions. (4) It is based on sampling. Hardly ever does the statistician have data on *all* cases which he is studying. He usually works with facts about a selected few which are known or supposed to be a typical sampling from the total group. He observes this sampling and derives from it some kind of statistical formula for predicting how the whole mass would also behave. (5) It looks to what is com-

mon rather than to what is unique. It seeks to derive from a number of cases a general rule, law, or formula which expresses a universal relationship that holds true for all cases of that kind. In other words, it is a refined instrument for arriving at inductive conclusions.

2. Limitations of statistics. It has been said that "figures can't lie, but liars can figure." Also that there are three kinds of liars, "liars, damn liars, and statisticians." It has further been often said that the science of statistics suffers more from the folly of its friends than from the onslaughts of its enemies. Calculations are not ends in themselves, but amateurs sometimes delight in making them so, much as a small boy delights in whittling with his first pocket knife. Each calculation that is made should be made for a definite purpose, clearly seen beforehand. The science of statistics is like any ordinary machine or tool. Its operator must assume responsibility for the planning and direction of its work. A physician does not mechanically add the patient's temperature, pulse rate, and blood pressure and divide by three to find the nature of the malady, but novices in educational research do comparable things with data. When the statistician becomes a part of his machine, without the ability or inclination to plan and reason about his work, he should stop figuring. The average statistical study involves more errors of policy, aim, or underlying philosophy than of computation or mathematical performance. The latter can be eliminated by the use of instruments and careful checking, but the former are not so easily detected. Someone has suggested that the statistician should beware of letting his mathematics smother his common sense. That is, he should check his work for

its logical soundness as well as for its technical accuracy. Formulae and figures are good as far as they go, but they do not go the whole way. To borrow a figure from city life, it is well to ride the street car to the end of the line, but after that it is necessary to get off and walk the rest of the way. It is a wise man who knows enough to stop figuring when figures have exhausted their possibilities, or to refrain from beginning to figure until he knows what the figuring will do for him.

3. How to learn statistics. The work of the statistician is a highly specialized one, calling for definite training in regular classes or schools. When more research workers come to appreciate this fact the quality of the output will be improved. Since, however, there are numbers of persons who are already in situations which call for statistical knowledge but who lack that systematic preparation, the following points may be of some service as guides of a self-help nature: (1) The beginner should study an extremely simplified book rather than one written for the training of real statisticians. In fact, it is sometimes better to find a statistical chapter in a book on tests and measurements or child study than to try to study a regular statistical book which goes more deeply into the technical aspects of the subject. Such methods do not make a statistician, but one must learn to crawl before he can run or dance. (2) It is well to compare treatments of a given process, as finding the standard deviation, in two or more books, since each explanation is in different words and involves different illustrations. (3) Reading journal articles which involve statistical techniques adds a kind of understanding not furnished by ordinary textbooks, since the processes are carried out in

their natural settings or in connection with definite practical problems, whereas textbook explanations present the problems in the abstract. If the reading of the articles is accompanied by reference to the textbooks on statistics, the results are greatly increased. (4) If a problem is once begun, the need for statistical tools will furnish such a powerful motive for their acquisition that ordinary statistical skills may be acquired to satisfy the immediate needs. (5) For many purposes learning how to use formulas mechanically without understanding their deriviation or theoretical background is all that is necessary. Many able persons can compute coefficients of correlation, and can interpret them, but cannot write the formula from memory nor tell why it is arranged as it is.

4. Accuracy. Every statistical calculation should be checked for accuracy, else one error may do more harm than the rest of the work can atone for. Work should be considered wrong and conclusions false until the opposite is proved. The following suggestions should be of some service in the promotion of accuracy in this work: (1) Every table or column of data should be clearly labeled at the time it is written down. The results of elaborate experiments have been known to be reversed simply because of accidental mistaking of the scores for one group for those of the other. (2) The use of slide rules, adding machines, tables of squares, reciprocals, etc., is to be encouraged. (3) Doing the same thing by two methods permits each method to check the other. For example, adding figures downward checks on adding them upward. (4) Simply looking for results that are "out of line" is a good way to detect errors. If an item is markedly different from others in its class, it may be right, but it should be

given special scrutiny instead of being taken for granted. (5) Common sense or estimation methods will reveal many errors that are hard to discover by more exact forms of checking. For example, to check the computed standard deviation by noting whether it includes about two-thirds of all the cases is often better than following through the computation in detail. (6) The original data and enough of the calculation should be included in the record or report to enable the checking for accuracy to be done over again later either by the investigator or by those who are to make use of his findings.

5. Aids to calculation. There are several devices available for lightening the burden of statistical calculation which should be brought to the attention at this time. They are as follows:

(1) *The slide rule.* This is a small calculating instrument which costs from one to ten dollars according to quality, and which is especially good for multiplication, division, finding squares, cubes, square roots, cube roots, etc. It does not add or subtract, nor does it permit accuracy in calculations beyond the fourth digit, but most problems do not require greater accuracy than this.

(2) *Calculating machines.* There are now available many calculating machines which may be had for the price of a typewriter, which will do almost any kind of computation desired. They are usually slower than the slide rule, but have the advantage of doing some things which the slide rule will not do, and also of doing the work with greater accuracy.

(3) *Logarithms.* Tables of logarithms are useful in almost exactly the same situation and for the same purposes as the slide rule. They have the same limitation

as the slide rule, also, as regards accuracy, since they only yield four, or in some cases five, significant digits of the number. They are used constantly by reputable statisticians, however, in spite of these limitations. It should be stated here that the slide rule is an invention which grew out of logarithms, and is in a sense a graphic logarithm table. Logarithms require more time than the slide rule, and in the writer's opinion are not nearly so useful to the statistician.

(4) *Tables.* In recent years numbers of books of tables have been published to facilitate statistical work. They include tables of squares, square roots, reciprocals, products, quotients, etc., for the different numbers up to 1000 or 10,000, as well as the Probable Errors, Standard Deviations etc., of different statistical quantities. Speed and accuracy are sometimes considerably increased by looking up what is desired in such a book of tables instead of calculating it independently.

TABLE IV.

AN ILLUSTRATION OF A FREQUENCY TABLE WITH INTERVALS OF ONE

Age	*Frequency* (Number of children)
5	3
4	6
3	6
2	2
Total	17

6. Selection of statistical tools. The difference between the rough carpenter and the fine cabinet maker lies in the number and variety of tools which are used

skilfully. The man who knows only how to work with a saw and hammer is comparable to the statistician who knows only how to compute an average. A successful research statistician must not only possess a wide variety of statistical tools but also know how to choose them appropriately for their specialized functions. A finished job calls for the use of many different techniques. The remaining paragraphs of this chapter are devoted to brief descriptions of these various techniques. The purpose is to serve as an outline for further study rather than to complete the training required for statistical research.

TABLE V.

AN ILLUSTRATION OF A FREQUENCY TABLE WITH INTERVALS OF TEN

I. Q.	*Frequency*
140-9	1
130-9	2
120-9	6
110-9	8
100-9	10
90-9	9
80-9	7
70-9	5
60-9	2
Total	50

7. Frequency distribution. If we had a group of pre-school children whose ages were 3, 2, 4, 3, 4, 4, 3, 2, 3, 4, 5, 4, 3, 2, 3, 5, 4, respectively, and wished to get a clear mental grasp of their ages we would make a "frequency distribution" by getting all of a kind to-

gether, as in Table IV. If, however, we were dealing with intelligence quotients of 50 second graders in which there was a range in scores from 60 to 145 we should find it convenient to bunch the scores by tens, as in Table V. Two slight variations of this are found when the frequencies are expressed in percentages of the total, and cumulatively, as in Table VI. These frequencies may also be represented graphically, giving a still more vivid picture of the distribution of the scores.

TABLE VI.

AN ILLUSTRATION OF FREQUENCY TABLES IN RAW FREQUENCIES, PERCENTAGES, AND PERCENTAGES CUMULATIVE.

I. Q.	*f*	*f* in %	*f* in % cumulative
140-9	1	2	100
130-9	2	4	98
120-9	6	12	94
110-9	8	16	82
100-9	10	20	66
90-9	9	18	46
80-9	7	14	28
70-9	5	10	14
60-9	2	4	4
Total	50	100	—

8. **Central tendency.** There are three common ways of finding the average, or central tendency, of a set of figures, as follows. (1) The *mode*. This is found by making a frequency distribution and observing which score has the highest frequency. In other words, it is

TABLE VII.

AN ILLUSTRATION OF THE SHORT METHOD FOR COMPUTING THE MEAN

I.Q.	f	d	fd
140–9	1	4	4
130–9	2	3	6
120–9	6	2	12
110–9	8	1	8
100–9	10	0	0
90–9	9	−1	− 9
80–9	7	−2	−14
70–9	5	−3	−15
60–9	2	−4	− 8
Total	50		−16

Formula: $M = AM + \frac{Sfd}{N} \times \text{Int.}$

$AM = 105$
$Sfd = -16$
$N = 50$
Int. = 10

$$M = 105 + \left(\frac{-16}{50}\right) \times 10 = 101.8$$

Note:

M, mean
AM, assumed mean
S, algebraic sum of
N, number of cases
Int., class interval
d, deviation from assumed mean

the score that occurs most often. It is not used very extensively. (2) The *median*. This is the mid-most score, or the one above and below which there are

equal numbers of scores, regardless of how far above or below it they chance to go. It is used quite commonly as a method of eliminating the effects of a few exceptionally low or high scores. It is found simply by counting up to the middle of a frequency distribution from either end and stopping when half of the total number of scores have been passed. (3) The *mean.* This is the ordinary average, determined by adding all the scores and dividing the total by the number of scores. Since, however, this is usually rather long, and since also the standard deviation is also desired at the same time as the average, a short method is commonly used which consists of computing deviations from an assumed or guessed mean and making a correction for the error in guessing later. A sample of such a computation is given in Table VII, based on the frequency distribution previously used. This procedure should be studied more in detail in a regular statistics book, after which this brief presentation may be used for reference.

9. Variability or dispersion. In addition to learning the central tendency, or average, it is usually important to know how closely the scores concentrate around it and how widely they vary or deviate from it. There are several ways in which this can be determined, as follows: (1) *Frequency curves.* Simply drawing a graph to represent the frequencies shows in a visual way how much they vary from the center of the distribution. (2) *Quartiles.* These are determined in the same fashion as the median, except that, instead of finding the middle point of the distribution, the points are located above which there are three-fourths and one-fourth, respectively, of all the cases. (3) *Standard deviation.* This measure is based both upon the number and the

amount of the deviations from the central tendency. In an approximate way, it is defined as that distance above and below the average which it would be necessary to go to include the middle two-thirds of the cases. It is easily computed as a byproduct of the calculations already shown to illustrate finding the mean. In order to illustrate it and to review the computation of the mean, another example is given in Table VIII, adding only one column especially for the standard deviation. Since the mean for this distribution is 13.73 and the S. D. 5.58, we are prepared to say that approximately two-thirds of all the scores, or 22 scores, would be included between the limits 13.73+5.58, or 19.31, and 13.73—5.58, or 8.15, a fact which can be verified by observing the distribution itself. (4) *Probable error.* This is derived from the standard deviation by simply multiplying the latter by the constant, .6745. It is interpreted in exactly the same way as the standard deviation, except that it is the distance above and below the mean required to include the middle fifty per cent of the cases instead of the middle two-thirds. Thus, in the example given, since S.D. is 5.58, P.E. is .6745×5.58, or 3.77. Consequently, we should find about one-half of the 33 cases between the limits 13.73+3.77 and 13.73—3.77.

10. Correlation. Two variables are said to be correlated if a variation in one is accompanied by a definite and systematic variation in the other. For example, since weight of children increases as their height increases, they are said to be positively correlated. Likewise since the number of errors made in practicing typewriting tends to decrease as the amount of practice increases, we say that errors are negatively correlated with amount of practice. The degree of cor-

TABLE VIII

AN ILLUSTRATION OF THE COMPUTATION OF THE MEAN AND STANDARD DEVIATION TOGETHER

Scores	f	d	fd	fd^2
24–26	1	4	4	16
21–23	3	3	9	27
18–20	5	2	10	20
15–17	6	1	6	6
12–14	7	0	0	0
9–11	6	−1	−6	6
6– 8	2	−2	−4	8
3– 5	2	−3	−6	18
0– 2	1	−4	−4	16
Total	33		+9	117

$$M = 13 + \frac{9}{33} \times 3 = 13.73$$

Formula: $$S\,D = \left[\sqrt{\frac{Sfd^2}{N} - \left(\frac{Sfd}{N}\right)^2} \right] \times \text{Int.}$$

$Sfd^2 = 117$
$N = 33$
$Sfd = +9$
$\text{Int.} = 3$

Therefore:

$$SD = \left[\sqrt{\frac{117}{33} - \left(\frac{+9}{33}\right)^2} \right] \times 3$$

$$= 5.58$$

relation may vary all the way from perfect positive (1.00) through zero correlation (0.00) to perfect negative (-1.00). When there is a certain amount of agreement but not perfect, it results in a fractional coefficient, as .56, .74, -.32, etc. For practical purposes correlations below about .20 are ordinarily considered negligible, .20-.40 low, .40-.60 substantial, .60-.80 high, and .80-1.00 very high. Care should be observed in regard to interpreting correlation coefficients, to avoid assuming that correlation proves causal relationship. For example, weight and height are positively correlated, but weight can hardly be said to cause the height, nor height the weight, since they are both dependent upon such other factors as age, hereditary influences, etc. The accompanying model for computing the coefficient of correlation, shown in Table IX, is made very simple by including only a small range of scores, and the beginner will find it necessary to study the subject in regular statistics books, but after once learning the procedure, this model may be useful for reference. No attempt is made here to explain the derivation of the formula. The reader may take for granted that it is true, or else study its derivation elsewhere. All steps in the first four columns at the side and at the bottom of the table are already familiar to the reader who has studied the procedure for the mean and standard deviation, the letters x and y representing deviations of the respective variables from the assumed means. The numbers in small type within the various cells are simply the products of the individual cell frequencies and their respective x values. The numbers at the bottom of the table in the fx row are simply the algebraic totals of the numbers in small type. The totals for the fx column should be the same as for the fx row,

TABLE IX

ILLUSTRATION OF THE PROCESS OF COMPUTING A COEFFICIENT OF CORRELATION.

(Correlating arithmetic grades with test scores.)

Test Scores	Arithmetic Grades E	D	C	B	A	f	x	fx	fx^2
27–29			1 2	3 6	5 10	9	2	18	36
24–26			5 5	11 11	12 12	28	1	28	28
21–23		2 0	3 0	19 0	8 0	32	0	0	0
18–20	1 −1	5 −5	13 −13	14 −14	1 −1	34	−1	−34	34
15–17	2 −4	8 −16	6 −12	2 −4		18	−2	−36	72
12–14	4 −12	1 −3	1 −3			6	−3	−18	54
f	7	16	29	49	26	127		−42	224
y	− 2	− 1	0	1	2				
fy	−14	−16	0	49	52	71			
fy^2	28	16	0	49	52	197			
fx	−17	−24	−21	− 1	21	−42			
fxy	34	24	0	− 1	42	99			

Formula:

$$r = \frac{Sfxy - \frac{(Sfx)(Sfy)}{N}}{\sqrt{Sfx^2 - \frac{(Sfx)^2}{N}}\ \sqrt{Sfy^2 - \frac{(Sfy)^2}{N}}}$$

In this problem:

$Sfxy = 99$
$Sfx = -42$
$Sfy = 71$
$Sfx^2 = 224$
$Sfy^2 = 197$
$N = 127$

Substituting, we find

$r = .57$

since they are both the same thing arrived at by different routes. If these do not check, there is some error in the work. The fxy row is based on multiplying each fx by its corresponding y value three rows above it. It should be noted that correlations may be computed between scores in numerical form or between letter grades, the main essential being that the intervals used are equal steps throughout for a given variable.

11. Curvilinear correlation. The procedure for the preceding paragraph is based on the assumption that the relationship is of a straight-line type, but this is not always the case. For example, we might presumably find a curved-line correlation between size of class and efficiency of instruction on the assumption that very small classes do poor work for lack of a social stimulus, that medium sized groups do better, and that extremely large ones break down from excess numbers. If such were the case, we would probably find no correlation by the straight-line formula but an appreciable amount of correlation if the other formula were applied. The procedure of computing curvilinear correlation is too complicated to warrant presentation here. The research worker who finds a need for it should consult other statistical books for detailed directions. The method of finding whether the labor of computing it will be justified or not is to plot the scatter diagram as for the straight-line correlation and observe whether or not it shows a concentration along a curved line. Unless its curvilinearity is visible to the eye from the scatter diagram, it is probably not worth while to make the extra calculation.

12. Partial correlation. It is not uncommon for two variables to be correlated with each other simply be-

cause each is dependent upon some third variable. For example, if we should find a correlation between a student's notes and his grades, we would not know whether the notes affected the grades or whether good notes and good grades were both due to high intelligence. The device by which we can answer this question is called partial correlation. It seeks to find what the correlation between two variables would be if the effect of a third one were held constant. Of if a fourth, fifth, or still other factors are suspected of being present, they may also be held constant. Thus partial correlation serves somewhat the same purpose in statistical work as controlling conditions to hold all variables constant except the one to be studied plays in experimental work. The experiment would not allow these other variables to enter into the situation. The statistical study lets them operate as they will, and then discounts their influence by means of partial correlation. The formula for holding one variable constant is:

$$r_{12.3} = \frac{r_{12} - (r_{13})(r_{23})}{\sqrt{1-(r_{13})^2}\ \sqrt{1-(r_{23})^2}}$$

The formula for holding two variables constant is

$$r_{12.34} = \frac{r_{12.4} - (r_{13.4})(r_{23.4})}{\sqrt{1-(r_{13.4})^2}\ \sqrt{1-(r_{23.4})^2}}$$

13. Multiple correlation. The purposes of multiple correlation is to determine what correlation would result if two or more scores were weighted in the most favorable proportions possible and this composite score correlated with some third score, or criterion. For example, the investigator wishes to predict success in algebra. He has already correlated intelligence with

algebra grades, getting a coefficient of say .54. He has correlated arithmetic and algebra grades, getting a coefficient of say .68. The correlation between arithmetic grades and intelligence he has found to be, say .37. His problem then is whether a weighting of the arithmetic grades and the intelligence scores in the most favorable manner possible would result in a better correlation than arithmetic alone gave. The formula for this is:

$$R_{1.23} = \sqrt{\frac{r^2_{12}+r^2_{13}-2r_{12}\times r_{13}\times r_{13}}{1-r^2_{23}}}$$

Thus in our own case, calling algebra grades 1, intelligence scores 2, and arithmetic grades 3, we have

$$R_{1.23} = \sqrt{\frac{(.54)^2+(.68)^2-2\times .54\times .68\times .37}{1-(.37)^2}}$$

$$= .87$$

Since .87 is appreciably higher than .68, it is clear that it would be desirable to make the composite score by weighting the intelligence scores and arithmetic grades. Otis gives a formula* for determining the best weights, which is as follows:

Total score = 1st score + W(2d score)
where

$$W = \frac{r_{13}-r_{12}\ r_{23}}{r_{12}-r_{13}\ r_{23}} \times \frac{SD1}{SD2}$$

For formulas for multiple correlation with many variables, the reader should consult Buckingham's article.**

*Otis, Arthur S, *Statistical Method in Educational Measurement*, World Book Company, Yonkers, New York, 1925, p. 241.

**Buckingham, B. R., *Multiple Correlation*, in *Journal of Educational Research*, Vol. IX, Feb., 1924, 149-154.

14. Regression equations. The purpose of the regression equation is to predict the most probable score in one variable from a knowledge of the score in another variable that is correlated with it. Thus, going back to our illustration of the correlation between arithmetic grades and test scores, we see that they are correlated to the extent of .57. If a child's grade is E, what did he most likely make on the test, or supposing he missed the test, what would he probably have made if he had taken it? The formula for predicting x from y is

$$x = y \times \frac{Sfxy - \frac{(Sfx)(Sfy)}{N}}{Sfx^2 - \frac{(Sfx)^2}{N}}$$

It will be observed that these items are all available from the correlation computation sheet. Similar but somewhat more complicated formulas are available for predicting one variable from the combined knowledge of several other variables.

15. Reliability. Since practically all statistical calculations are based on limited samplings taken from the total population, there is always a question or doubt as to whether the findings for the observed sampling would hold true for the whole group, or for other similar samplings taken from it. It is for the purpose of answering this question that reliability must be determined for any statistical quantity which is based on a sampling. When reliability has been determined, it is possible to know how certain the same results would be to occur again upon further sampling. For example, it is possible to predict from

a given observed sampling what the odds are that further samplings would give results above zero. It is impossible to explain here the theory of the formulas for reliability, except to say that they are based on the mathematics of probability and the normal probability curve.

We shall only state a common rule of the statistician that for a quantity to be "significant" or for us to possess "practical certainty" that it would still hold true for other samplings, it should be 4.0 times its Probable Error (P.E.) or 2.78 times its Standard Deviation, (S.D.) There are two common procedures for checking up a quantity to see whether it meets this test, one being the "critical ratio" and the other the "experimental coefficient." The *critical ratio* is simply the ratio between the quantity and its P.E., expressed in decimals. For example, if the mean of of the sampling were 16.3 and its P.E. were 3.9, the critical ratio would be $\frac{16.3}{3.9}$ or 4.2. Since a ratio of 4.0 indicates significance, or practical certainty, we would say that we are certain that other samplings would yield a mean somewhere above zero. The logic of the *experimental coefficient** is the same as that of the critical ratio. Using the illustration above, with a mean of 16.3 and P.E. of 3.9, we would go back to the S.D. which would be 5.8. The ratio between the mean, 16.3 and its S.D., 5.8, is $\frac{16.3}{5.78}$, or 2.82. Since this ratio should be 2.78 or more in order to have

*This device is described in great detail in McCall's *How to Experiment in Education*, and seems to be of his own invention. The writer considers it one of the most convenient methods of testing reliability that are available.

practical certainty, it is clear that it slightly more than meets the test. But how much more? This may be answered by computing a further ratio, namely $\frac{2.82}{2.78}$, or 1.01. For convenience both of these steps are combined into one formula, which is as follows:

$$\text{E. C. (Experimental coefficient)} = \frac{M}{2.78 \text{S.D.M.}}$$

The same thing may be expressed in the corresponding form for Probable Error, which would be:

$$\text{E.C.} = \frac{M}{4 \text{ P.E.M.}}$$

It now remains to give formulas for determining reliability for various statistical quantities. These will be expressed in terms of S.D. and experimental coefficients, since P.E. and critical ratios may be easily derived from these if desired. The P.E. is always .6745 S.D., and for a quantity to be 4 times its P.E. is practically the same as for it to be 2.78 times its S.D.

(1) Reliability of a mean:

$$\text{S.D.M.} = \frac{\text{S.D. scores}}{\sqrt{N}}$$

$$\text{E.C.} = \frac{M}{2.78 \text{ S.D.M.}}$$

(2) Reliability of a difference between two means:

$$D = M_1 - M_2$$

$$\text{S.D.D.} = \sqrt{\text{S.D.M.}^2{}_1 + \text{S.D.M.}^2{}_2}$$

$$E.C. = \frac{D}{2.78\ S.D.D.}$$

(3) Reliability of a sum of two means:

$$S. = M_1 + M_2$$

$$S.D.S. = \sqrt{S.D.M.^2{}_1 + S.D.M.^2{}_2}$$

$$E.C. = \frac{S}{2.78\ S.D.S.}$$

(4) Reliability of a sum of three or more means:

$$S. = M_1 + M_2 + M_3 + \ . \ . \ . \ + Mn$$

$$S.D.S. = \sqrt{S.D.M.^2{}_1 + S.D.M.^2{}_2 + S.D.M.^2{}_3 + \ . \ . \ + S.D.M.^2 n}$$

$$E.C. = \frac{S}{2.78\ S.D.S.}$$

(5) Reliability of a difference between the sums of two or more groups of means:

$$D. = S_1 - S_2$$

$$S.D.D. = \sqrt{S.D.S.^2{}_1 + S.D.S.^2{}_2}$$

$$E.C. = \frac{D}{2.78\ S.D.D.}$$

(6) Reliability of a standard deviation:

$$S.D.sd = \frac{S.D.}{\sqrt{N}}$$

$$E.C. = \frac{S.D.}{2.78\ S.D.sd}$$

(7) Reliability of a correlation coefficient:

$$\text{S.D.r.} = \frac{1-r^2}{\sqrt{N}}$$

$$\text{E.C.} = \frac{r}{2.78\ \text{S.D.r}}$$

(8) Reliability of a difference between two correlation coefficients:

$$D. = r_1 - r_2$$

$$\text{S.D.D.} = \sqrt{\text{S.D.}r^2{}_1 + \text{S.D.}r^2{}_2}$$

$$\text{E.C.} = \frac{D}{2.78\ \text{S.D.D.}}$$

(9) Reliability of a partial correlation coefficient:

$$\text{S.D.}r_{1\,2.\,3} = \frac{1-r^2{}_{1\,2.\,3}}{\sqrt{N}}$$

$$\text{E.C.} = \frac{r_{1\,2.\,3}}{2.78\ \text{S.D.}r._{1\,2.\,3}}$$

(10) Reliability of a multiple correlation coefficient:

$$\text{S.D.R.}_{1.\,2\,3} = \frac{1-R^2{}_{1.\,2\,3}}{\sqrt{N}}$$

$$\text{E.C.} = \frac{R_{1.\,2\,3}}{2.78\ \text{S.D.R.}_{1.\,2\,3}}$$

McCall gives the values of the E. C. up to 1.5 in terms of chances that further samplings would yield quantities above zero.* Thus an E. C. of .1 involves

*McCall does not carry his table beyond 1.5, but it is readily seen that the odds are so enormous for an E. C. of this size or larger that there is no need of the exact numbers.

chances of 1.6 to 1; .2, 2.5 to 1; .3, 3.9 to 1; .4, 6.5 to 1; .5, 11 to 1; .6, 20 to 1; .7, 38 to 1; .8, 75 to 1; .9, 160 to 1; 1.0, 369 to 1; 1.1 930 to 1; 1.2, 2350 to 1; 1.3, 6700 to 1; 1.4, 20,000 to 1; 1.5 65000 to 1.

EXERCISES AND QUESTIONS

1. Why is the statistical method considered so important in educational research?
2. Criticize the statement that ability to use a formula is more important than understanding how it is derived.
3. How can a greater amount of common sense be combined with statistical research?
4. What are the main qualifications essential for a successful statistician? How can these best be acquired?
5. What justification can you give for the statement that slide-rule accuracy is usually as much as is needed in educational research?
6. Formulate a number of research problems from your own schools that would involve the statistical technique.
7. What are the dangers in presenting a brief and simple statement of statistical technique, such as the one in this chapter? What are the advantages? How may dangers be avoided?

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CHAPTER XIV

TABULAR AND GRAPHIC TECHNIQUE

The value of graphs. An old proverb has it that "one picture is better than a thousand words." Not infrequently graphs will convey an idea better than any amount of verbal explanation and better than the most elaborate tables of statistical data. They not only have a power to convince which has long been appreciated by the advertising experts, but they have another value beyond this. They are excellent devices to aid the research worker to analyze his facts and to study or understand what they signify. This function of graphs is often not duly appreciated, since the common idea is that graphs are to show others what has been discovered, rather than to help the research worker to discover it. The making of a graph, therefore, is not necessarily a final step in the study. It is more often a step leading to a more complete discovery of the meaning and significance of the data.

In passing, we may mention the fact that sometimes graphs prove to be useful tools or labor-saving devices in certain statistical operations. For example, the process of converting a large number of intelligence test scores into percentile ranks or of turning minutes into percents of a class hour, may be facilitated by plotting the line to represent the relationship between the two variable and reading the results from the line instead of making a mathematical calculation each time.

Since the use of graphical and tabular devices is so essential in research work, the remaining portion of this chapter is devoted to some ways to increase their effectiveness.

I. Types of Graphs

1. Bar graphs. A very common type of graphical representation of facts is the bar graph. It consists of a rectangular bar for each group, individual, city, or item that is being described. The lengths of the bars indicate the relative magnitude of the cases compared. The bars may represent such things as the total expenditures of different cities, the average scores of several classes on an arithmetic test, or the average amount of improvement in handwriting for each of several classes during a semester's time. Likewise, bars may be used to compare boys and girls as to a number of abilities, with a pair of bars to show each comparison, one pair showing average grades of boys and girls in arithmetic, another pair in reading, etc.

2. Spot graphs. There are many kinds of problems which require a method of showing how the individual cases are distributed over a given geographical area, or over a given range of statistical scores. For this purpose a map may be drawn and upon it a spot may be marked for each case, or else a pin may be stuck in it for each case. Thus a spot or pin may be used to locate each consolidated school in a county, each high school student's residence in a city, or the spot at which each juvenile crime was committed.

A slightly different kind of spot graph is that in which a set of scores is arranged into class intervals in which one dot is marked beside each interval to

represent one case, the frequencies being shown by the number of dots or tallies recorded.

The scatter diagram is a slightly more complicated form of the spot graph just mentioned. It involves locating spots so that each shall represent the status of a given case with respect to two different variables. For example, height may be shown along the horizontal axis, and weight along the vertical, and a dot located at that point which would express both the correct height and the correct weight for the child.

3. Organization charts. A type of graph which is exceedingly useful in studying the administrative organization of a school is the organization chart. It involves the use of a square or rectangle for each official or member of the school staff, with the connecting lines to show sources of authority and responsibility for each. Imperfections in the organization which are very difficult to discover otherwise become glaring realities when reduced to such graphic form.

4. Time series charts. In statistical investigations which trace a given phenomenon through a series of months or years, it is frequently desirable to draw a line to show the course of the phenomenon, with its various ups and downs. The familiar charts to be seen in the newspapers showing the trends of bond prices, living costs, etc., by years or months illustrate this type of chart. Similar charts for school data are common, of which the learning curve is probably the most familiar.

5. Circle graphs. Not infrequently a graph is needed to show amounts of the different parts composing the whole of something, as, for example, the different items composing the total expenses of the school, or the amounts of the different sciences included

in a course in general science. A very effective way to show such differences is by means of the circle graph, with each component part represented by a "pie slice." This is usually preferable to the use of concentric circles, and also better than squares within squares, since it leaves as the sole basis of comparison between the parts the portion of the circumference which represents them. When concentric circles are used for the various parts of the whole, the comparisons are based on length of radius instead of length of circumference, and are therefore deceiving, because areas of pie slices are directly proportional to the circumference but areas of circles vary as the square of the radius.

6. Histograms and frequency polygons. One of the most common situations calling for graphical representation is that in which it is desired to show the actual distribution of all the cases in a given group, or to compare two groups or sets of scores upon the basis of all cases, rather than simply on the basis of averages. For this purpose, the histogram and frequency polygon are very useful. They simply involve graphic presentation of the facts shown by the frequency distribution (See chapter on statistical technique), either in the rectangular form that results from allowing a square to stand for each case, or else in the polygon form that results from joining the midpoints to represent frequencies.

A problem in the use of frequency polygons which sometimes gives trouble is that of comparing groups of different sizes. This is facilitated if the polygons are reduced to the same scale. The easiest way to do this is ordinarily by expressing the frequencies in the form of percent of the whole. Thus, if there are

thirty students in one group and forty in another, the graphs for the two groups may be reduced to the same scale quite readily by reducing them both to the scale of one hundred.

7. Percentile graphs. The percentile graph is a slight but very useful modification of the frequency polygon. It is based on the ordinary frequency distribution but involves two interesting variations. (1) The frequencies are cumulative, each being added to the total below it, so that the frequency recorded at the end of the range is the total of all frequencies in the whole distribution, or one hundred percent of the cases. (2) These cumulative frequencies are next converted into percents of the total frequencies, and these percents are used in the actual construction of the graph. Needless to say, two or more percentile graphs may be drawn upon the same paper, thus comparing scores for different groups, schools, etc., in much the same way as is done by the use of frequency polygons. Very full and detailed treatment of this type of graphs is to be found in Otis' *Statistical Method in Educational Measurement.*

II. Captions for Tables and Graphs

Because of the common tendency of beginners in research to neglect certain essentials regarding the titles for tables and graphs, and labels for their various parts, it has been thought best to include here a few directions concerning these points.

1. Numbering. A standard rule for tabular and graphic work is that each table and each graph should bear a definite serial number. It is customary to number tables and graphs in separate series, using Roman numbers for tables and Arabic numbers for

graphs. The practice of presenting numerical materials informally, and without the dignity of a definite table number, is especially to be condemned, as is also that of presenting some charts or diagrams as "strays" or "orphans" while others are recognized as important enough to receive serial numbers. If tabular or graphic materials are important enough to be included in the report, they should be important enough to receive recognition in the number series.

2. Title for the table or graph as a whole. Each table or graph should bear not only a serial number, but also a title or caption which is expressive of its meaning or contents. It is unwise to make it necessary that such explanatory matter be secured from the body of the text. The caption should tell clearly whatever is needed for the understanding of the table or graph, or, if doing so would make it too long or voluminous, it should tell it in a brief way and refer to an explanatory note at the bottom of the page, in which may be included all necessary detail. Special care should be exercised to avoid errors of capitalization in titles. A common error is that of attempting to capitalize the first letters of principal words, a method which is seldom done in any consistent way. Ordinarily it is better to capitalize only proper names. It is customary to place the number and title for a table above the table and for a graph below the chart.

3. Identification of the parts. Not only should each table or chart as a whole be identified clearly, but also each of its separate parts. To assume that the reader will understand what each line or set of numbers stands for is to invite error or confusion. If there are different colors, or solid and broken lines, a "legend" may be shown, indicating what each color or each kind

of line stands for. The same purpose may be served by arrows pointing to the different items, leading in from explanatory labels written in uncrowded portions of the page, and also by titles written parallel to or above the parts to be identified. A good rule is to leave no column, row of figures, line, or area without a clear identification of some kind to enable it to be easily understood.

III. Suggestions Regarding Form

There are many matters of form and arrangement of tables and graphs which are of quite general application. It is not possible to present here a complete list of rules and standards for good form. Such lists may be found in the books referred to at the close of this chapter. The suggestions presented here are those which have grown out of the examination of about fifty research reports, chiefly master's theses, and cover the points which seemed to be in greatest need of improvement.

1. Suitability to the purpose. It frequently happens that the same data may be presented in many different ways, or by several different kinds of tables and graphs. In such cases one should not be satisfied until he has drawn up each of the several types to compare their effectiveness. A little experimenting with different plans with a pencil and rough paper will ordinarily go far toward discovering the exact type of graph or table that is best for the particular purpose that is to be served.

2. Loose-leaf plan. Each table or graph should be put on a page by itself in the manuscript, instead of sharing a page with another table or graph or with the subject matter of the written report. This is

because the typist or printer cannot adjust the report to make such units come at any certain predetermined portion of the page, and will be obliged to insert them at other places than that of the writer. If they are on separate pages, they allow maximum freedom of arrangement by the typist or printer.

3. Boundary lines. As a general rule a table or graph should be surrounded by lines to show its limits. Particularly does this apply to a graph, since the numbers which accompany it must be arranged at its edge, and are more effective if they are along a definite line. Not every graph or table requires boundary lines, but many times they would be a real improvement.

4. Neatness. Careless work in tables and graphs is distinctly undesirable. Since the whole purpose is to present a visual appeal, neatness is extremely essential. One of the greatest aids to neatness is the use of rulers and instruments to secure straightness and smoothness of lines. Lines drawn freehand are usually slightly irregular and present an untidy appearance. The use of small circles or dots to locate intersection points is also superior to the use of crosses, as the latter present an untidy appearance. Evenness in the heaviness or darkness of lines also is an essential of neatness.

5. Simplicity. It is unwise to attempt to show everything in a single table or graph. As a rule each one should be a unit, or present a single message. The principal justification for showing two things in the same table or graph is in order to accomplish the *single* result of comparing the two. When a table or graph is made to show several different things, it

frequently fails to show any of them effectively because of their obscuring each other. Also, the more complex it becomes, the less certain it is of being understood. The safest thing is to present each fact or idea in a table or graph of its own, and then to present comparisons or summaries in separate ones which have the sole purpose of comparing or of summarizing.

6. Scale. The scale to which a graph is drawn has much to do with its effectiveness, or even its truthfulness. Facts can be distorted by the simple device of magnifying the vertical scale and reducing the horizontal scale so that the two are out of proportion. Petty differences can be magnified in this way until they appear to be very important differences. After having determined the proportions which will set forth the facts truly, it is often important to experiment further to select the size or scale which will best fit the paper used or that will harmonize best in appearance with what is adjacent in the report.

7. Smoothing. The effectiveness of a graph is often spoiled because of extreme variations up and down so that no general trend is readily observable. Two learning curves on the same page, for example, may cross and criss-cross so many times that it is difficult to say which is the better. Such a difficulty is easily solved by means of smoothing, or drawing the general trend of the data without the details. Several methods of smoothing may be used, but one very simple one is that of reducing the number of class intervals by increasing their size. A learning curve which presents an entry for each three-day average will be smoother than one which gives a separate entry for each day. Another way to smooth a curve is to reduce the scale

of the graph in the direction in which the fluctuations occur. In addition to these devices, there are the ordinary statistical procedures for smoothing.

8. Orderly arrangement of items. When several items are presented in a table or graph, they should be arranged according to some systematic plan and not be entered in miscellaneous order. Thus the states of the Union may be listed alphabetically, in order of rank in population, or on some similar basis. Bar diagrams might well be arranged in ascending order of rank as to length of the bars, and "pie slices" in a circle graph should be arranged so that thick and thin slices are not alternated.

9. Grouping for comparison. When graphs or tables are to be used for purposes of comparing two things, the items to be compared should be so grouped as to lend themselves to such comparisons. Thus, adjacent columns in the tables should be assigned to the things to be compared instead of allowing intervening columns to be occupied by figures relating to some other aspect of the situation. Thus if each of two groups is described in terms of "number" and "per cent," there should be a pair of columns for "number" and a pair for "per cent," instead of a pair for "Group I" and a pair for "Group II." Similarly if bar graphs are to be used for comparison, it is important that the bars be grouped in pairs close together, with wider spaces between pairs than between the members of a pair.

10. Zero point shown. To omit the zero point in a graph is often enough to defeat the whole purpose of the graph. For example, if two bars are used to contrast average grades of boys and girls, the boys averaging 84.89 and the girls 84.25, to begin the bars with 84.00 as the base line would leave the impression that

the girls had grades only about a third as high as the boys when in reality the grades are almost identical. If including the zero point would make the graph too long, a break may be made between it and the end, shown by a wavy line, to indicate that a part of the intervening space has been left out.

11. Numbers to accompany graphs. The numerical data upon which a graph is based should always be made available. As a rule, it is well to put this information on the page with the graph itself by writing the numbers along the boundaries of the graph or by presenting them in tabular form beside or below the graph. Care should be exercised to avoid locating numbers at the ends of bars in such a way as to give the visual impression of lengthening the bars. When graphs are wide, it may be well to record the number scale at both sides, or at both the top and the bottom, to facilitate reading quantities from either edge. In some cases this plan may be varied by putting the actual numbers on one side and their equivalents in per cent on the other.

12. Reading position. A table or graph should be so constructed as to permit it to be read from the bottom of the page or from the right. For this reason, all writing should be either horizontal or upward, but never downward, since writing downward necessitates turning the page so the table is viewed from the left.

13. Relation of tables and graphs to the text. A good rule in the preparation of tables and graphs is to assume that the reader has not and will not read the discussion in the text, and that his sole information about the things treated in the tables and graphs comes from them only. If possible, they should be clear enough to be intelligible without the text. Then the

discussion in the text might well be written very much as if the tables and graphs did not exist, with special care taken to make the discussion intelligible without referring to the tables and graphs for interpretation. This does not mean, however, that the text should enumerate all that is presented in tabular form, but rather that what it does treat should be intelligible in itself. Each table or graph presented on a page to itself as mentioned before, will necessarily have to be referred to in the text. This should not be done in such a way as "The following table shows——" but "Table XVI shows——," since it will be impossible to predict whether in the final report the table will follow or precede the reference to it.

IV. Materials and Procedures in Constructing Tables and Graphs

It is not within the scope of this chapter to enter into detailed discussion of drawing materials or technique. At best we can hope here only to point out in a general way a few of the principal forms of equipment and a few suggestions on technique which are applicable to the person who has not had special training in mechanical drawing.

1. Typewriting. By exercising a little forethought it is possible to prepare many tables and graphs so that they can be copied on the typewriter and thus be made a standard rather than a technical process. In order to do this, it is necessary to be familiar with the typewriter keyboard and mechanism, and to consider with some care the number of spaces included in a line of typewriting, as well as the space required to typewrite particular words. Some graphs are such that all but a few lines can be produced on the typewriter, and these

can be inked in afterward. As a general rule, whatever can be done on the typewriter can also be done in print, since the printer has a greater freedom in selecting and arranging type than has the typist. It is not always economical, however, to have a table or graph set up by the typist or printer, as the labor charge may be greater than that involved in other processes.

2. Lettering. Writing the numbers, titles, and identifications of the various parts of tables or graphs presents difficulty to persons who have not had special training in the art of freehand lettering. There are several ways of overcoming this difficulty, as follows: (1) It is possible to hire this work done by persons who have had the necessary training. (2) The lettering may be done on the typewriter, special care being taken to get a ribbon which writes with the same degree of darkness as the other parts of the graph. (3) It is possible to purchase transparent pieces of celluloid substance with the various letters and numbers cut through to serve as a guide to the pencil or pen. These, however, are usually difficult to operate. (4) For some purposes ordinary handwriting, if of good quality, may be entirely adequate. As a general rule, good handwriting is preferable to poor lettering.

3. Pens. Special drawing pens of various types are available for those who can use them. For the amateur, however, it may be better to work with more familiar tools. One very simple device of non-technical type, however, will be of considerable service, particularly in the making of wide lines or bars. It is possible to secure pens with points as wide as a fourth of an inch, which will make a smooth and even line with one stroke. The commercial name of one such set of pens is "Speed Ball Pens." Such pens overcome

the difficulty of having a bar made up of light and dark streaks due to uneven distribution of the ink on different parts of the paper.

4. India Ink. The use of India Ink in graphs is important for a number of reasons. It is opaque, and serves to stop the light from going through the paper, thus lending itself well to the preparation of blueprints. It is superior, also, for photographing purposes, and is, therefore, essential in any graph that is to be reproduced by photostat or engraving. It makes a very sharp and distinct impression which lends effectiveness to a graph even though it is not to be reproduced at all.

There are a few points which the amateur should know about using India Ink: (1) It forms a cake when it dries and hence should be cleaned out of pens and instruments promptly. (2) It should be allowed to dry on the paper, and never be blotted as other ink is, since blotting removes practically the whole impression. (3) It should never be erased in the usual way. Erasures, if made at all, should be made by a sharp knife or razor blade, removing the cake of ink and not disturbing the tissue of the paper. (4) Corrections should be made before rather than after erasures are made, the new letter or number being written over the old, and then the old erased after the whole is thoroughly dry. If an erasure is once made, the new and moist ink tends to spread through the roughened paper, making it impossible to get a neat line.

5. Colors and their substitutes. Not infrequently it is desired to represent different items by different colors, as, for example, the different nationalities in a school, or the errors and the time in a learning curve.

If the graphs are to be made entirely by hand and never reproduced in quantities, this is quite feasible, and the contrasting colors are very effective. But if they are to be copied, colors are quite a problem, as color printing is very expensive.

The common substitute for colors is the device of varying the texture of the line while using plain black. Thus one line may be solid and another dotted, one bar solid and another hollow or cross-hatched in different directions, etc. Graphs constructed on this principle may be photographed or blueprinted without difficulty.

6. Cross section paper. It is possible to secure paper ruled according to almost any imaginable pattern and suitable for almost any kind of tabular or graphical work. It is well for the research worker to have at hand samples of many different patterns so that he can choose the style or scale that fits his needs best. It is not necessary, in every case, for the cross lines to be shown on the graph itself, but such lines are necessary as guides in constructing the graphs. A helpful device in such a case is to draw the graph on transparent paper with a sheet of cross section paper underneath to furnish a guide to go by. If lines are needed in the graph to help read it, it is usually preferable to use the printed graph paper instead of drawing cross lines especially for the purpose, both for reasons of economy and of increased effectiveness of the graph. Cross section paper can be bought or ordered through any good bookstore or stationer.

7. Blueprinting. One of the cheapest and most satisfactory ways of duplicating a table or graph is by blueprinting it. The first essential is that the material to be copied be drawn on transparent paper or tracing

cloth. Ordinary onion skin, or even thin typewriter paper, will serve the purpose. This copy should be done in India Ink, or else on the typewriter. If done on the typewriter, a very black ribbon should be used, and a black or red carbon paper placed underneath in such a position as to make a second copy of the material on the back of the paper. These two layers of black materials ordinarily serve about as well as one layer of India Ink. An ordinary black lead pencil and a carbon paper may also be used in much the same way as the typewriter.

When the copy has been prepared, by any one of these methods, it is sent to a blueprint company, who make copies of it exactly as if it were a photograph negative. The cost of such copies is very low indeed, usually only a few cents a square foot.

If a positive print is desired, a second copy, or Van Dyke print, may be made from the original, this being just the reverse of the original tracing, and from it may be printed any desired number of blueprints which are dark where the tracing is dark and light where it is light.

8. **Photostatic processes.** A very useful device for reproducing tables, graphs, or similar materials is the photostat process. This involves simply the making of a photograph of a page or chart, reducing or enlarging it to such size as desired. This makes it possible to draw a very large graph and then reduce it to a standard page size, in which minor errors and inaccuracies of the drawing would be reduced so greatly as to disappear from notice. This device permits of making a clear and readable reproduction that is smaller than the hand could possibly make. In preparing work to be photostated, it is

necessary to be careful lest certain lines be too faint to show at all on the reduced copy.

Closely related to the photostat process is engraving. It involves simply taking the picture on a sensitized metal plate, after which the metal is dissolved out chemically except at those places where the light has caused a chemical which is insoluble to be formed. These parts which are not dissolved thus stand up higher and receive the printer's ink and print black whereas the others do not, thus forming a printed copy of the original graph.

9. Folding. Not infrequently a chart or table is larger than the standard page on which the research report is to appear, thus being in a sense in the "awkward squad." Two remedies for this are possible. The chart may be reduced in size by the photostat process, or it may be folded and inserted. If the latter is done, care should be taken to be sure that when the report is bound, the folded material can still be opened up for inspection, and also that the outer folded edge does not come near enough to the right to permit the trimming knife to cut it. In other words, it should be a bit undersized when folded. As a general rule it is well to avoid graphs and tables which require much folding, and to use instead a larger number of graphs which present parts of the findings separately.

EXERCISES AND QUESTIONS

1. How does the value of graphs to the research worker compare with their value to the readers of the research report?

2. Arrange the various types of graphs mentioned in this chapter according to their order of usefulness in educational research. Justify your rating.

3. Using data supplied in the chapter on statistical technique, construct for yourself as many different types of graphs as you can.
4. Let each member of the class construct a graph to represent the same set of data and then compare the different graphs made.
5. Read some article or book that has many graphs and criticize the effectiveness of the various graphs used.
6. Go through a published research report and note as many things in it as you can that could be representd graphically.

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CHAPTER XV

LIBRARY TECHNIQUE

1. Research based on books. There are several factors which operate in favor of basing research activities upon the study of books instead of upon experiments, tests, interviews, and similar direct sources of information: (1) The investigator may be so situated that the latter types of procedures are not available to him, as in the case of full-time graduate students who do not have schools or classes of their own to study directly, and who therefore find it more convenient to resort to books and libraries. (2) Barriers of space and of time sometimes make it difficult to study a particular problem except through the medium of printed materials which bear on it. (3) Some problems, and some fields of knowledge, lend themselves very little to other than bookish procedures, as, for example, legal problems or problems in literature and history. (4) Some research problems have to do with the comparison or classification of viewpoints which leading writers have expressed about certain questions, in which case their publications naturally constitute the chief source of information available.

In view of these factors, and of the common tendency of thesis writers and others beginning research to rely too heavily upon printed materials instead of upon assembling unpublished data, a warning should be issued against indiscriminate and unscientific use of books in research. The fact that a study is to be based on books rather than on concrete observations

does not excuse the research worker from his responsibility as a scientist. He should treat his printed materials as systematically and as critically and as objectively as he would any other kind. Furthermore, he should formulate his problem just as carefully and precisely as if he were employing some other kind of technique.

The various situations in which reading enters into the life of the research workers, and the principal points in the technique of using books scientifically are treated in the remaining paragraphs of this chapter.

2. Reading about research technique. One type of reading which the prospective research worker must necessarily do is that designed to acquaint him with the technique he is to employ in his investigations. He must read to train himself in scientific methods of work. If he proposes to do historical research, he should by all means read books on historical method. Likewise one who expects to do experimental, statistical, or job analysis research should learn all he can about these procedures by such reading as he can do. If he can get access to regular courses in research methods, so much the better, but, if not, he must make up the lack by his own self-directed effort. This may be accomplished in part in connection with graduate courses, seminars, and term papers, but much of it will probably remain to be done as a part of the more immediate preparation for the actual writing of a thesis or getting started off on an investigation. Unless considerable training in research technique has already been received, probably the best thing a beginning research worker could do would be to devote a few weeks to a campaign of self-education in the

techniques he expects to employ in his investigation.

3. Reading for general background. Another type of reading which should be done by a research worker is that which provides an orientation in the general field in which his investigation is to lie. For example, an education student must be familiar with the history, psychology, sociology, philosophy, administration, methods, measurement, and other phases of education before he is competent to do really scientific work in any one of these lines. If he has not had such a background or orientation, the reading of at least one outstanding book in each of these lines should be done as a corrective for the lack. Also it would be well, as a means of providing a more immediate form of background, to read *all* articles in a few current issues of the leading educational journals, whether they are related to the thesis problem or not. Such a reading of a representative sampling of recent educational writings provides somewhat a cross-section view of the field of education which broadens the view and improves the perspective.

In addition to these types of orientation, it may sometimes be necessary to do a different type of reading by going over into the related subjects. An education student will profit by reading books on sociology, biology, anthropology, etc., in addition to his background reading in the field of education itself.

4. Reading about the particular research problem. Next after reading on research technique and reading for general background, comes reading on the specific problem which is to be investigated. This has several aspects, or factors, to be considered: (1) Merely familiarizing oneself with a number of writings on the immediate problem that is to be studied gives a rich-

ness of mental association about it which serves as excellent material in thinking about it. (2) The conclusions reached by other investigators serve somewhat as proved theorems in geometry upon which later work may be based without going back to prove them anew each time they are needed. (3) Such reading helps to suggest new problems that are to be solved. (4) It enables one to avoid doing again what other investigators have previously done. (5) It enables credit to be given where due to previous investigators. (6) It suggests improved techniques that might not be discovered by working alone. (7) It warns against faulty or inadequate techniques that have already been tried out and found wanting. (8) It enables one to revise his own research plans before he does his experiment instead of after he has spent his time and energy upon its performance. (9) It safeguards his originality if he will read *many* or *all* other studies, since the reading of only one or two will leave him a slave to them, whereas a large number will present so many viewpoints as to produce a state of mental independence. (10) Extensive reading of similar studies *after* one's own study has been finished aids in interpreting the results which have been secured. (11) If the other studies which are read are in the form both of articles in journals and also in complete theses, they supplement each other admirably, since the articles yield a clear perspective because of their condensed nature, and the full reports give a wealth of detail on the technique of the investigations. (12) The results of the reading of other investigations on the problem may be incorporated into the research report in the form of a chapter with such a title as "Survey of Related Investigations," and thus

give the reader the same sort of orientation as that which the research worker gained by doing the reading.

5. Using books as original sources. It is entirely possible to conduct investigations based upon published materials and have as high standards of scientific merit as if the data used were secured from original research. For example, the United States Census Reports contain large quantities of data which may be used in the solution of problems which the governmental authorities have not attacked. Likewise, many research reports which have been published contain data which are capable of being treated in other ways than have been attempted by their authors. A new investigator may take such a report, with its tables of original data, and "work up" this material to solve other problems than those which have been solved, or to check and verify the solutions arrived at by others.

There is still another sense in which books and printed matter may be used as original sources of information. An illustration is involved in such a problem as "A survey of Junior High School English as revealed by printed city courses of study," which would call for an examination and tabulation of the contents of the city courses of study from a number of different cities. Such materials are just as truly original data as are scores on tests or replies to questionnaires. In the effort to be objective and scientific, it is well to keep a sense of perspective, and to beware of rejecting or neglecting sources of information merely because they are in print. Not everything that is in print may be called original data, by any means, but much of it may be used in scientific ways if utilized properly.

6. Using books as secondary sources. Many times a book cannot be truly considered as an original source, but may nevertheless be extremely useful as an aid in a given piece of research. A secondary source, or a book which talks about some original data collected by others rather than one which presents original data of its own, may be helpful in locating the original data, and also in interpreting them. It may be used to stimulate a check-back to the original data, and a verification of them; or it may give a clearer idea about what facts are lacking, and thus direct the search for new data of an original sort. Furthermore, the fact that a given book or article is simply a discussion of the actual facts presented by some other author does not by any means indicate that it lacks sicentific merit. If a good scientist makes a critical estimate of another person's investigation, his report is a secondary source but a quite reliable and valuable one. It is better to depend upon good secondary sources than upon poor and inadequate original ones.

7. "Interviewing" books. A type of investigation which may well occupy the time of graduate students and research workers is the taking stock of educational writings upon a set of definite questions, issues, or problems. For instance, the topic for the investigation might be "A survey of the status of theme-writing in the published works on the teaching of English." This would then be particularized by the formulation of such questions as: (1) Is the recommendation favorable or opposed to theme-writing? (2) How long should themes be? (3) How should topics be selected? (4) How should themes be criticised? etc. The investigator would then examine carefully the published materials on the teaching of English to find how each

author answered each of these questions, and thus secure data upon the way that body of experts reacts to theme writing. Such a procedure would permit of numerical tabulations regarding the number who favored assigning topics as contrasted with the number who favored freedom of choice by the students, and similar questions. A slightly different style of "interviewing" that might be applied to books would be that which seeks to discover and list in one place the methods suggested by the various writers for performing some particular operation or solving some teaching difficulty. Thus the investigator might go through a number of books for their answers to such questions as "How to make Latin contribute the maximum amount to the improvement of English." The results of interviewing books might be handled in such ways as are suggested in the chapter which treats interview technique. Such a plan is ordinarily better than simply reading at large upon a subject and writing a paper on what seems to stand out in the mind as a result of the contacts made.

8. **Making comparisons and contrasts.** A type of problem which permits of a scholarly and systematic use of printed materials is that which makes comparisons or contrasts between two bodies of literature. For example "A comparison of the philosophies of Plato and John Dewey" affords a chance for a rather far-reaching comparison, based upon a search through two rather large bodies of writings for parallels and contrasts upon a number of different points. Another type of comparison and contrast is that illustrated by the *Literary Digest,* which presents the whole range of views, opinions, and attitudes that have been expressed about a given question. While such procedures are

not suited to statistical treatment, as a general rule, and therefore may not appeal to persons who hold strongly to the ideal of extreme objectivity in research, they may have much to commend them especially if they are used by competent persons and with due regard for their limitations.

9. Analyzing space distribution in books. A form of investigation which is particularly suited to use with printed materials is the study of the amount of space given by different books to particular types of subject matter. For example, general science textbooks may be studied with respect to the percentage of space given respectively to physics, chemistry, botany, zoology, physiography, etc. Or arithmetic textbooks may be examined as to the amount of space given to drill exercises as contrasted with presentation of principles, or to reasoning problems as contrasted with pure drill problems, etc. This procedure is applicable also to materials other than textbooks. The books on the teaching of art, for example, may be analyzed to determine relative space given to art appreciation, design, painting, etc. Such studies may be made by counting the number of chapters, pages, lines, or even words devoted to the different types of material, the size of unit depending upon the nature of the problem and of the material used.

10. Preserving objectivity in using published materials. A caution which is especially in order in connection with the use of secondary printed materials is that against subjective treatment of these materials. An opinion stated by an author may be accepted as *his opinion,* and treated as such, without sacrificing standards, but the research worker should make it very clear that the opinion is so recognized and used.

The fact that an opinion is held by even a foremost authority is not necessarily enough to establish a fact. Even that person may have been guessing or mistaken. It is well to look for the evidence which formed the foundation for the opinion, and if none is available, to put the responsibility for a given statement upon the person who made it instead of taking personal responsibility for its truth. It is better to express other person's opinions as theirs rather than to express them as if they were one's own, even if the latter is accompanied by a footnote reference to the previous author. In other words, it is well to shift the responsibility for statements of opinion upon those who have expressed them, just as it is well to put the responsibility for strictly scientific conclusions upon the original data instead of bearing that responsibility oneself. Even if a viewpoint seems unimpeachable, one's own attempt to defend it before others may not be so successful.

11. Finding references. The technique of making a bibliography is a rather specialized one, and one which calls for some little special training. Ordinarily the graduate student or research worker will have had access to some such training in his previous educational experience. If this is not the case, he might do some special reading and study on the art of using a library, learning the special functions of the various guides and the special techniques involved in using them. Some of the leading indexes which should be learned are the *Card Catalog, United States Catalog, Cumulative Book Index, Reader's Guide, Reader's Guide Supplement, International Index, Poole's Index to Periodical Literature,* and various encyclopedias, yearbooks, and special bibliographies.

EXERCISES AND QUESTIONS

1. Explain why research is so commonly associated with books and libraries in the popular mind.
2. Compare the use of books and libraries with the use of other techniques discussed in this book as to their scientific value.
3. Is a "reading thesis" more or less likely to be scientific than an experimental one? Why?
4. Formulate a number of research problems that seem to lend themselves particularly well to a reading type of research.
5. Read a few reports of research based on reading and criticize the procedures and conclusions reached.
6. How would research reading differ from reading for other purposes? Why?
7. What types of books or other library materials should the library purchase in order to make the greatest possible contribution to educational research?

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CHAPTER XVI

ANALYSIS AND INTERPRETATION OF DATA

Importance of analysis and interpretation. A clerk can do the routine portion of an investigation, but it takes a real research worker to interpret the results and draw conclusions after the clerical work is finished. Mere juggling of figures or tabulating facts is not research. Research involves a considerable amount of reflective thinking. Drawing conclusions is a thoughtful rather than a mechanical process, and cannot be done in a mechanical way. Nor can it be done hastily. It requires a maturity of consideration which necessitates a long period of time while it is in process. Research workers have been known to *find* facts with infinite care and precision and then to *explain* them with the utmost recklessness, giving no reasons for their conclusions or giving as reasons for them what could be at best mere guessing. Certainly the finishing stages of an investigation deserve to be done with as great care as the other parts; yet they are frequently done with the least care of all.

Two reasons explain a large amount of the neglect of the analysis and interpretation phase of investigations. (1) The effort to be objective sometimes comes to be a fetish in the mind of the one making the study, so that he cannot, even for a moment, let himself resort to anything which in the least way resembles the resort to opinion or speculation. And yet drawing conclusions must necessarily consist in the exercise of rational or speculative processes in connection with the

facts which have been assembled. (2) The drawing of conclusions is not uncommonly left to the last, at which time the investigator has become thoroughly tired of his study, or has developed a condition of mental staleness which causes him to shirk the strenuous process of critical analysis and interpretation. More effort to formulate tentative conclusions as the study progresses, and to record these for later consideration, would serve to some extent as a corrective.

There are two principal evils to be commonly found in research reports. One is the evil of failing to get out of the data all the conclusions of which they are capable; the other is the evil of drawing conclusions not warranted by the data. The remaining paragraphs in this chapter will offer a few suggestions to help remedy these evils.

I. Making the Data Yield All Conclusions of Which They Are Capable

In the effort to discover everything of significance which may be secured from the data, many different procedures and devices may be employed. The following are a few of these:

1. Reading. After the data have been assembled and such conclusions drawn as seem justified, a period of reading on the subject may aid in extending the process of thinking the matter over, and thus help to produce other significant conclusions. This reading may be directed toward other investigations which have been made in the same field, or toward the writings of persons who have dealt in a less scientific way with matters related to the problem. In fact, the reading of unscientific materials may direct attention to issues or phases of the question which would be overlooked

if the reading were limited to the strictly research materials that have been published.

2. Consulting the records of the study. If proper records have been kept as the study progressed, they should be fruitful sources of mental stimulation when the time comes for drawing conclusions. These records should contain not only the actual data collected, but also information about the numerous conditioning factors and circumstances that accompanied the collection of the data. Since the conclusions must necessarily take account of these conditioning factors, a careful survey and minute examination of all records of the investigation should add something to the list of conclusions to be drawn.

3. Subdividing the whole. It is ordinarily better to begin the search for conclusions by examining each part or aspect separately rather than by attempting to interpret the investigation as a single unit. Failure to draw adequate conclusions is simply due in many cases to working with too large a unit. Not infrequently, a part may suggest as many significant conclusions as does the whole, thus enriching the results as many times as there are parts so analyzed. Simply dividing the study up into its phases, aspects, or chapters is, therefore, a fruitful way of studying it for significant conclusions.

4. Placing items in new combinations. It is sometimes possible to discover new significance in a fact simply by placing it alongside another fact. It is said that the invention of the Eskimo Pie was due to the accidental dropping of some chocolate frosting into an ice cream freezer, upon which it promptly hardened and thus revealed a new principle which has resulted in thousands of dollars worth of business to the con-

fectioners. Proximity is a factor favorable to discovery of likeness, cause and effect, etc. Hence the mere putting of facts into positions adjacent to each other may aid in revealing their hidden meaning. Or, conversely, if two things happen together, they may profitably be examined to see if they are related to each other in any way; or if one follows the other, it may be examined to see if it was caused by it. Frequently the failure to draw sufficient conclusions is due to the failure to find the connecting links between facts which are together and related, or to put them together so that their relation could be observed.

5. Classifying. To classify facts involves getting all of a kind together and separating all that are different from each other. This enables a generalization to be made regarding each class or group of items, and thus promotes reducing the whole to a state of order, system, or law. When all cases of a kind are together, their agreement or uniformity is much more apparent, and much more accurate limits or boundaries can be set for the laws which are involved in them. If the same facts are classified, cross-classified, and reclassified on many different bases or from many different viewpoints, their full significance is more likely to be discovered than if they are only classified in one way. Using only one classification means getting only a very small fraction of the potential meaning of the facts.

6. Generalization. The chief aim of most research is to discover the uniformities, laws, principles, or generalizations that run through a large number of specific cases. Until a fact or number of facts can be reduced to such a law or formula, the problem has not been solved, nor the work of the investigator finished. In other words, the conclusions reached should, in a

sense, represent the central tendency, or average, or most truly representative feature of all the individual instances which have been studied. This requires classification, comparison, and contrast, and leads to a discovery of the common elements running through the various situations or cases, with the definite recognition of the fact that these are the common elements.

7. Looking for exceptions. A single instance which differs in some way from all of its fellows is a potential source of knowledge about some new factor not previously known. New planets have been discovered by the astronomers because of their further study of planets which seemed to disobey the known laws of astronomy as if being acted upon by other forces. Any fact or case that seems to disagree with a hypothesis or generally accepted belief, if properly followed up, may lead to a revision or correction of that hypothesis. Each exception is a signal for further thought to see why it is different.

8. Treating the data statistically. The failure to draw sufficient conclusions from a study is sometimes due to failure to apply the available statistical techniques to them. If the mean or median is computed and the process stopped at that point, naturally the conclusions are meager. But if in addition to a single measure of central tendency there is computed other central tendencies, measures of dispersion, correlation, alienation, reliability, etc., the number of conclusions that may be drawn is greatly increased. The research worker should make an extra effort to apply to his data every procedure or form of treatment which is appropriate to them and which can be used in a purposeful way instead of stopping when he has applied one method of treatment.

9. Writing a report of the investigation. Until an investigation has been written up in full and complete form, the full meaning of it is not grasped by the investigator. The act of writing up the results refines and completes the thinking and interpretation of the facts assembled. Writing thoughts down defines and clarifies them, and brings into prominence ideas which previously were present only in the fringe of consciousness. Any defects or errors in the conclusions reached are more likely to be discovered if recorded in actual black and white. In short, the surest way to get all the conclusions out of a study which it is capable of yielding is to report the study in full and complete form. An investigation which is carried out "just for curiosity," and is never written up in definite form for a thesis or for publication as an article, is almost certain to be a relatively unfinished job, and to stop before it reaches many of its potential conclusions.

II. Guarding Against Unwarranted Conclusions

The previous section has dealt chiefly with the problem of discovering the significance of data and formulating all possible conclusions; the present section is to consider the ways by which the drawing of conclusions not justiged by the facts can be avoided.

1. Verifying major premises. Just as a building placed upon a weak foundation cannot stand, so a long chain of reasoning or an elaborate structure of theory built upon a false major premise is certain to topple sooner or later. For this reason, it is extremely important to avoid building upon untested assumptions. It is unsafe to take anything for granted, as it may turn out to be false and invalidate all work done from that point on.

2. Checking for internal consistency. One check that may be employed to test the value and soundness of conclusions drawn is whether or not they are consistent with themselves. If the various parts of an intellectual structure or theory that has been built up fail to agree with each other, the probability is that something is in error. For all aspects of an elaborate body of findings to be consistent with each other does not establish beyond a doubt that they are all true, but it does furnish rather strong circumstantial evidence that such is the case.

3. Checking against external criteria. Not only should all conclusions be consistent with each other, but also with objective facts or external realities. External consistency is a safer test of the soundness of theories than internal consistency. However, consistent a line of reasoning may be, it should not be accepted as true until it has been verified in the light of other criteria of some kind. Unless the theories actually work out in practice, they are of doubtful worth. It is safer to put faith in the senses than in reason when the two disagree, and to adjust the reasoning to what the senses reveal rather than to shut out from the senses what fails to agree with the conclusions previously reached.

Incidentally, we might remark that a very useful external criterion by which to check conclusions drawn from an investigation is the body of facts and conclusions arrived at by the other investigators who have worked in the field. If the findings of a study are not in agreement with those of other studies that have been made, they may well be submitted to a careful reexamination for possible errors.

4. Getting the criticisms of other people. It is well,

in a certain sense, to be a pessimist about conclusions that are drawn, and to assume that they are all wrong until they are proven right. Or, to put it differently, it is well to assume that no one will accept the conclusions which have been drawn, and that all who read them will find fault with them. This consciousness of an audience to be convinced and satisfied is a very wholesome and restraining influence, causing the investigator to examine his facts with much greater care than he would if he had only himself to satisfy.

Not only should conclusions be drawn with a prospective audience in mind, but they should be checked by being actually submitted to such a critical audience. A presentation of the findings to a small group of research people, or to a graduate seminar, for criticism will usually result in a discovery of the weaknesses and fallacies that are involved, and thus give an opportunity to make necessary revisions before publication. Such a practice, incidentally, would prevent the serving up of some of the "half-baked" conclusions which are put before the public each year and which do more to injure the cause of science than to advance it.

5. Avoiding common fallacies. There are certain typical errors which are quite common not only in research but also in everyday life, which may well be mentioned here with the hope that if the investigator is forewarned, he may be prepared. They are as follows: (1) Mistaking correlation for causation. It is not necessarily true that two things are related to each other because they happen to be together. One might be the cause or the result of the other, or both might be caused by some third and unseen influence. Likewise, it is unsafe to assume that because one event follows another it was caused by it. (2) Generalizing

upon too few cases. "One swallow does not make a summer," but one instance of a phenomenon of human behavior is frequently the only basis for a geenralization about "human nature" whether it was a typical case of behavior or not. This sort to error is extremely common. (3) Generalizing from unrepresentative data. Great care is needed to avoid assuming that all teachers believe the same as the few teachers who volunteered to answer a given questionnaire, or that all children react in the same way as the group which was included in a given experimental study. The research worker is constantly tempted to state as general or universal laws the conclusions which hold true for the small group of cases included in his study. (4) Mistaking a part for the whole. It is extremely difficult to avoid a tendency toward finality due to limited perspective. The beggars, in Tolstoy's story, who quarrelled with each other as to the nature of the elephants because each had felt a different portion of their bodies, are comparable to many students and scientists who disagree among themselves because each has discovered a different part of the truth and has mistaken it for the whole. (5) Comparing things that are not comparable. This tendency to reason that because two things are similar in a few particulars, they are similar in all, is a most fruitful source of error. Such uncritical reasoning by analogy has been one of the chief sources of superstitions and scientific errors. (6) Ignoring negative evidence. A common trait of human nature is the tendency to ignore cases which disagree with notions which are already held, treating them as "exceptions that prove the rule." By thus shutting the eyes to opposing facts it is possible to build up a feeling of utmost certainty about matters that are abso-

lutely false. (7) Yielding to suggestion. The tendency to accept a statement as a fact without asking for a reason is a frequent source of error. This tendency is especially hard to overcome if the source of the assertion or suggestion is a person of considerable prestige or prominence.

6. The law of parsimony. An old and very helpful rule for the scientist is that when several possible explanations of a phenomenon are available, the simplest should be chosen. "When in doubt, take the simpler interpretation," and "Accept the simplest explanation that will account for all the facts," are two common statements of this old "law of parsimony." Another statement of the same general idea is "That explanation is best which explains all the facts with the smallest number of assumptions." A few examples will make clear the significance and importance of this rule. It is preferable to account for such a phenomenon as lightning by means of natural laws of physics than to attribute it to a special supernatural cause. Or, again, it is more in keeping with science to explain the nest-building of birds on the basis of simple instinct than to make the assumpton of intelligence and foresight as causes of the nest-building. In short, it is always preferable to accept the lower and simpler in preference to the higher and complex explanation, provided it is equally able to account for all the facts.

EXERCISES AND QUESTIONS

1. How does Dewey's *How We Think* relate to the present chapter?
2. Of what value would a course in logic be as a part of the training of a research worker? Why?
3. Which do you consider the more serious error, failure to draw sufficient conclusions or drawing conclusions not warranted by the data? Why?
4. Examine the findings and conclusions of a number of research reports and criticize the soundness and adequacy of the conclusions drawn. What types of shortcomings do you note?
5. What are the surest guarantees of good results in drawing conclusions?
6. What is the difference between the drawing of conclusions in science and in philosophy?
7. Compare the value of internal and external consistency as standards for evaluating conclusions.

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CHAPTER XVII

REPORTING RESEARCH

We shall consider the research report from two viewpoints. The first is that of what to include; the second, the form in which to present it.

I. Content

The types of material discussed in this section, while not essential to every thesis, constitute the most common elements that deserve consideration in making the report. Incidentally, having such a list to go by, or such an outline to follow, may aid some struggling beginners to get into presentable form the materials which otherwise might be in part overlooked or else put into the records in a confused way.

As a general rule, it should be possible, although it is not essential, to organize the report in such a way as to give each of these parts a separate status apart from the others, either as a chapter or as a separate division within a chapter or in some way which gives it definite treatment as such. Some of these divisions may be consolidated into one chapter when they are short; some of them, when long and involved, will require several chapters.

1. Title. The title of a research report should be truly expressive of its contents. The use of short and catchy titles instead of significant and expressive ones is to be condemned, since the research report is of a more dignified nature and does not compete with the

journalistic type of writing. As a rule, the title is likely to be long, not because there is any virtue in a long title as such, but because the problem frequently does not permit of adequate statement in the briefer form.

2. **Tables of contents.** Most research reports will require three tables of contents: one for the ordinary chapter divisions and subdivisions, one for tables, and one for graphs and charts. These will ordinarily be listed as "Table of Contents," "List of Tables," and "List of Graphs and Charts" respectively. The table of contents should be rather detailed and analytical, since it must serve also the purpose of an index for the unpublished report; and the lists of tables and of graphs should be arranged in serial fashion with the titles of the tables or graphs given. It is ordinarily undesirable to combine the list of tables with the list of graphs, unless the number of each is very small.

3. **Acknowledgements.** A small space may be used, if desired, to acknowledge special courtesies and help rendered by persons outside of the line of duty, but ordinarily it is unnecessary to include in this section glowing tributes to the research advisor, since he has simply done what his position as research advisor presupposes.

4. **Problem.** The opening chapter of the report should ordinarily be a statement of the problem investigated. This should be so clearly stated that there can be no doubt or uncertainty as to what was sought in the study. Any vagueness in the presentation of the problem is likely to lead to vagueness or uncertainty in the later portions of the report. The problem may be stated in the form of a major question, followed by sub-questions, the answers to which are to be found in

the later chapters of the study. It is entirely permissible to state along with these the motives or reasons for the interest in them, or the benefits which might be expected to result from finding their answers. The problem chapter should not, however, constitute a "catch-all" for any miscellaneous material which is dear to the writer's heart but does not fit in anywhere else. The use of the word "Problem" instead of "Introduction" as the chapter title is preferable, since the latter tempts the writer to the practice just mentioned.

5. Related investigations. The treatment of other investigations which have been made upon the problem may take either or both of two forms. It may occupy a special chapter, designated by title as a summary of related investigations, or it may be distributed through the body of the report with a mention here and a footnote there as need arises. Ordinarily, a formal summary in one place is more effective in showing the history and present status of the problem, and in paving the way for the report on the present investigation. The giving of credit to other investigators in the body of the report should not be slighted, neither should footnotes and citations in the text be resorted to in a pedantic effort to appear scholarly. Such references, properly made, may add to the effectiveness of one's expression, and may serve as corroboration for conclusions arrived at, but when they are used just for show, they interfere with the reading of the report.

6. Procedure. The chapter on the procedure of the investigation should not only tell in detail what materials were used, what was done, and how the data were treated, but give also the reasons for doing these things as they were done. It should present the procedure in sufficient detail to enable the reader to criti-

cize and to judge its soundness, and also help him to make such judgments. The common tendency of the beginner is to make the procedure chapter entirely too short, or to mention a few of the high points of the procedure in some obscure part of another chapter, as if it were a matter of small importance, when as a matter of fact it is of the utmost importance, and the foundation upon which the rest of the report must rest. The procedure chapter should not only describe the procedure but also criticize it and present such evidence as is available to show how reliable or justifiable it was. It should show samples of the various questionnaires, directions, tests, or other materials used, and give any other information that is necessary to enable the reader to repeat the same identical procedure in a check experiment or investigation.

7. **Results.** One or more chapters may be required to present the results. Under this head comes the tables, graphs, and non-statistical facts discovered, together with the outcomes of special forms of treatment applied to them. The report should include not only the original data, but also the secondary data derived from them. Thus, if two sets of scores have been correlated, the report should include both the original scores and also the correlation coefficient derived from them. Omission of the former makes it impossible for any later investigator to check the latter. The results chapters should contain more than the bare statements of facts in tables, graphs, etc. These should be cemented together by running text material, which points out the significant or striking things shown in the tables and thus directs the reader's attention while he surveys the results.

8. **Shortcomings and mistakes.** Some weaknesses

are almost certain to be discovered in the procedure of every investigation by the time it is finished, however careful the investigator. Human nature is incapable of seeing far enough ahead to forestall every difficulty that might arise. Consequently, when it comes time to report the results, there will usually be a few shortcomings or weaknesses which mar the picture. It is much better to point these out than to cover them up or ignore them. Nothing spoils confidence in a report so much as discovery of a few signs of concealment of its defects, and nothing helps to develop respect for a report quite so much as frank self-criticism by its author. If the reader's doubts and questions are forestalled by the writer, or if the arguments on the opposite side of the question are presented before he has a chance to state them, he is much more likely to be convinced of the soundness of the conclusions reached. Furthermore, a statement of the pitfalls which were discovered in the study may aid later investigators to avoid them.

9. Further work to be done. A striking characteristic of almost every investigation is its tendency to raise other related problems in the mind of the investigator. By the time a research worker has solved one problem, he can usually see dozens of others that are demanding solution. It would be unfortunate indeed to let these fruits of the study go to waste. A special section or chapter might well be devoted to "Further work to be done on this and allied problems," in which might be mentioned new aspects of the problem that should be attacked, or new techniques which might be applied in the further study of aspects previously investigated. After working with certain tools for a time, the investigator may discover ways of im-

proving them or better ways of handling them, and if so these discoveries should be passed along for the benefit of others.

10. By-products. It is a rare case when an investigation fails to reveal anything of value besides what it set out to reveal. Oftentimes the by-products are more important that the original problem. These should be saved, whether of major importance or not, simply as a matter of record and for the service of other investigators who may be interested in them. Two ways are open for embodying them in the report. One is to include them in footnotes at such places as they seem to belong, thus relating them to the items which give rise to them without drawing attention in an undue degree away from the main stream of thought. The other plan is to devote a section or chapter to "By-Products" as such, and to present there all such findings as seem worth recording. If such a chapter seems to interfere too much with the main stream of the report, it may be placed in the appendix.

11. Summary. At the end of a long and involved treatment of a topic, it is well to give a brief terse statement of its essentials simply to provide a "handle" by which it may be more effectively grasped, or as a crystallization of what has been suspended for some time in a state of diffusion, as it were. Some scientific journals make a practice of publishing a summary of each article at the beginning of the article, others at the close. The full research report, however, will ordinarily require not only one general summary, but probably also a number of smaller summaries of the various parts along in the body of the report.

12. Conclusions. The chapter on "Conclusions" should constitute a natural counterpart to the chapter

on "Problem," since it presents the final results of the attempt to answer the questions stated in the problem chapter. This chapter may be either a brief list of points serving as answers to the problem questions, or it may be a longer chapter made up of the answers accompanied by the analysis of the factors which entered into the final judgment on each. In either case, there should be somewhere in the chapter a few terse statements of the findings which might be copied by the reader to preserve the whole thing in a nutshell. In other words, there is as much need for summarizing the conclusions as for summarizing any other portion of the report, if not more need.

13. Applications. Frequently the reader, on completing his perusal of a research report, is inclined to say something like: "A very careful and thorough study, but what of it?" In other words, it is to him pure science, and has no practical applications. If he has an opportunity to ask the author of the report this question, he usually finds that the author can more than justify the study on the grounds of practical applications. This suggests the value of devoting a definite section of the report to applications in which the author may point out to his readers the practical significance of his findings, and thereby remove his study from the ranks of pure science. It would be most unusual if the author of a research report saw no practical application for his findings—as rare, in fact, as if the readers were able to see as many applications as the author could—and, this being the case, he should put his ideas on record.

14. Appendix. There is considerable uninteresting material in every research report which interferes seriously with the reading of the report if embodied in

the text itself, but which should not be omitted entirely from the permanent records. The appendix is the logical place for this. It may include the names of the schools or pupils studied, the lists of dates upon which observations were made, the technical procedure involved in statistical calculations, the bibliography which accompanies the investigation, or any one of a hundred other possible things. Sometimes the cost of printing a report may be materially reduced by setting the main essentials in ordinary type and putting everything else in small type in the appendix.

II. Form

Having considered what to put into the research report, we are now ready to consider the form in which to record it. The following suggestions may not apply to all cases, and may even be contradictory, in some instances, to the published rules and directions regarding theses for certain graduate schools. Without attempting to be dogmatic or final, we shall set them forth here in the hope that they may be helpful where no better guide is available. The reader is urged to secure copies of such official booklets of directions or form specifications as his school makes available, and to follow them explicitly, relying upon the present chapter only in points which are not specified by such official publications.

1. Displaying the outline. One of the most important points regarding the form of the research report is that of displaying the outline. Instead of chapters that run from paragraph to paragraph without a break, the report should be organized into heads, subheads, and sometimes still smaller subheads, each with some form of prominent display. This plan of boldly setting

forth the main divisions and subdivisions enables the reader to skip and skim, and to find what he wants to know, as well as to get more meaning from each division. This display of the outline consists of two essentials, providing bold or prominent headings for the paragraphs and sections, and numbering or lettering these to indicate their relations to the outline.

2. Announcing series of topics. It is well ordinarily to avoid abruptly beginning upon a series of parallel or coordinate topics without a brief introductory announcement to prepare the mind for the series. Thus such a statement as "There were six steps in the procedure, which will be outlined in detail in the following pages," is preferable to simply beginning the description of the first step. Also, it is well to make such transition statements, as "Having seen——, we shall now turn to——" in order to smooth the path from one unit to the next.

3. Typographical details. To specify typographical details for a printed report is quite beyond the scope of the present paragraph, but there are a few hints which may be given here regarding the form for typewritten reports, chief of which are the following: (1) The same style of type should be used for items of a given rank throughout the book, and should not vary from chapter to chapter. (2) The few major divisions of a chapter may be represented by headings placed in the middle of the page in a "balanced" position. These headings may be assigned Roman numerals, and may be written in all capitals. They should not be underlined, but they should be given prominence by spacing an extra line before and after, thus permitting the heading to stand out in the middle of a relatively open place. (3) Subdivisions of the second rank may

be numbered in Arabics, if at all, and begun at regular paragraph position. Only the first word and proper names should be capitalized, and the entire heading should be underlined for prominence. The material of the paragraph should begin immediately at the end of the heading, wherever that may be, instead of at the beginning of a new line. (4) Subdivisions of still smaller rank may be assigned small letters instead of numerals and written the same as the next higher rank, without the underlining. (5) The plan of "capitalizing main words" should be avoided, as it adds to the trouble and expense of typing, aids prominence very little, and is almost impossible to carry out consistently. When attempted, it usually results in capitalizing some verbs but not all, or capitalizing long nouns and not short ones, and similar irregularities. The use of small letters or all capitals avoids these errors. (6) When long quotations are included, they should ordinarily be single spaced and indented slightly in order to be set off in appearance from the rest of the report.

4. Starting new chapters and sections. Standard practice is to begin each new chapter at the top of a new page, whether the last chapter ended at the bottom of the page or not. This does not apply, however, to the subdivisions within a chapter, which should begin wherever the previous ones end. Nor is it good form to leave blank spaces or unfinished pages before tables or graphs. If the graph is announced or referred to, or its discussion completed, in the middle of a page, the remainder of the page should be given to the discussion of the next one or the next topic in the chapter, avoiding the skipping of space. Otherwise a report that contains a large number of inserted pages

would present a very choppy and fragmentary appearance.

5. Length of chapters. The length of a chapter should be determined by its subject matter rather than by arbitrary or external considerations. If, however, a given phase of the report is very long and involves a very complicated outline, convenience and clearness suggest that it be subdivided into several chapters in order to simplify the scheme of presenting the outline of heads and subheads. In other words, if several short chapters will present the message more effectively than one long one, they should be employed.

6. Footnotes. The form for fotonotes can be readily observed by noticing almost any book, and need not take much space here. If there are many footnotes to the page, they should be referred to by means of numbers, but if only one or two the use of the single or double asterisk is usually easier to employ. If the report is to be printed, the footnote should follow immediately after the line to which it refers, set off by lines before and after it, drawn across the page. If, however, the report is not to be printed, it is ordinarily preferable to place the footnote at the bottom of the page.

7. Bibliographies. Standard forms for bibliographies may be found by consulting the library card catalog, the Reader's Guide, and similar library reference works. It may be well here to mention the importance of recording complete information for each reference instead of just a few of the necessary items. To omit such things as publishers, editions, dates, etc., may make the reference entirely worthless. Bibliographies should ordinarily be arranged alphabetically by authors, and attempts to classify the works into

such divisions as books, monographs, and articles should be avoided unless the maker of the bibliography has the skill and training needed to do it consistently.

III. Other Considerations

Besides the questions of form and content, previously discussed, there are certain general considerations relating to the research report which should be considered. These are given in the following paragraphs:

1. Organizing and writing the report. The actual process of organizing and writing the report will naturally vary with the problem and with the individual doing the work, but the following suggestions may have some general applicability: (1) Careful records of all steps in the study should be kept as the study progresses, in order to be available when the time comes to write them up. (2) All materials to be used in composing the report should be kept in loose-leaf form to facilitate classification and rearrangement. (3) An outline should be made *before* rather than *after* the report is written, in order to provide greater proportion and order in the whole report. (4) The job of writing the report should be divided into parts so that the author can do one at a time without having to be conscious of all the other parts at once. It is impossible to write the report as a whole or in general as a single unit. That is more than the mind can manage at one time. (5) A period of time should be allowed to elapse between the writing of the first and second drafts, in order to permit the mind to come back to its previous output with a fresh viewpoint.

2. Audience. Whether to address a research report to the specialist or to the laymen is a question of con-

siderable importance. Unless the report is written so that the layman can read and understand it, it is likely to fail to have much effect upon the actual practice or behavior of the laymen. There is a great need for popularizing the results of research, or of "humanizing"* knowledge, so that all may profit by the discoveries of the scientists. To write the report for laymen increases the size of the potential audience, since there are many laymen and few specialists. Also, it not infrequently happens that what is written for the layman is also quite serviceable for the specialist, and thus reaches all, while the converse is seldom true—seldom can the laymen understand a report written principally for the scientist. If the report is written to the popular reader and all technical matter is presented in footnotes or in the appendix, the results is applicable to either group.

But it is frequently difficult to make the report simple and non-technical and at the same time make it serve the purposes of the specialist. He is interested in the technique, while the layman is concerned chiefly with results. He is interested in many of the smaller details, while the layman is concerned more with the general nature of the conclusions. He wants answers to profound questions which the layman does not know exist. Consequently, he may be quite dissatisfied with a research report written to the popular audience.

Since the interests of the scientist and of the layman are both important factors to be considered, there are three possible courses for the writer of the research report to pursue, as follows: (1) To address it to the layman and put technical material in the footnotes or

*J. Harvey Robinson: "The Humanizing of Knowledge." The George H. Doran Company, New York, 1924.

appendix; (2) to address it to the scientist and include summaries of the main points in simple form for the popular reader; (3) to write the report to the scientist and then bring out a popular edition of the same report in a style that is suitable for the layman.

3. Style. The style of a report will depend to some extent upon the audience to which it is addressed, but several things apply to the style for any kind of audience. These may be mentioned as follows: (1) The report should be written up as a *report* upon an investigation rather than as an *essay* composed by the investigator. (2) It should be written in a modest vein, avoiding the use of the first person pronoun, I, and avoiding praise of the study or boastfulness about the importance of the findings. (3) It should be written in proisaic or matter-of-fact, rather than poetic or figurative style. Glowing similes and metaphors may catch the popular fancy, but they often lack the ability to impart ideas clearly and accurately. (4) It should be clear, so that it actually leaves an accurate and definite impression in the reader's mind. (5) It should be interesting. This is to be achieved more through relying upon the intrinsic merits of the investigation than by attempts at racy journalistic style or resort to anecdotes and facetious comments. (6) It should involve a reasonable amount of concreteness or of illustrative material which helps the mind to grasp the significance of the abstract elements. Technical terms do not have as rich a fund of meaning associated with them in the reader's mind as in the writer's; therefore some special effort on the writer's part is required to supply that deficiency. (7) It should be free from the encyclopedic tendency; that is, the report should be more than a miscellaneous presentation of numbers of

isolated details. It should represent an organization and sequence of points which impress the reader as being the natural and inevitable way in which they should be presented. This suggests that the material should not be presented in long unbroken paragraphs, and also that it should not be presented in long series of paragraphs without larger heads or classifications.

4. Scale. A common tendency of beginners in reporting research is to write the report on too condensed a scale. While the opposite tendency, or padding, is sometimes met with, it is not nearly so common in the case of conscientious persons who are really trying to do their best.

In general the scale upon which the research report is written should be one of considerable detail rather than of considerable brevity, for two main reasons:

(1) For understanding. The report is not nearly so clear to the reader as to the writer. After months of thought upon the study, the writer can hardly realize that others are not so well informed about it as he is. He tends to write the report to others who knows as much about it as he does, or to his research advisor who has counselled with him freely, and thus it tends to go beyond the comprehension of his readers. For this reason it is well to space out the report, giving paragraphs to points which seem to deserve lines or words, and thus allowing sufficient space in which to bring in explanations or illustrations of points. The beginner will need to do for his report somewhat the same thing that the physical director does with his students before a set of exercises. That is, he must "open ranks" and give room for each individual idea to develop itself. Possibly one of the most helpful pieces of advice to be given to thesis writers in regard

to this point is the injunction, "Don't crowd." There is room for everything in the report if it deserves a place, as there is seldom a page limitation (except in cases of publication) and there is no reason for crowding much into a little space.

(2) The second reason for a full and detailed report is the desirability of preserving a record of everything of any significance. A research report resembles a court record in that it is a depository for every fact or piece of information that could possibly have any significance, or that might need to be consulted at a later time. It is to be used later more for reference than for connected reading for pleasure, and for that reason should contain such information as may be desired for later reference. It should contain a sufficiently complete record of the procedure that the reader cannot only judge for himself whether the conclusions are warranted, but also that he could set up and carry out a second study identical to it for purposes of verification of the findings. It should not only report the findings in enough detail to lend conviction as to their soundness, but also include the original data, scores, or raw materials needed by anyone who wishes to check the calculations or to tabulate and treat the data by other supplementary procedures. If the report is to be of the maximum value to the cause of science, it should contain enough information to make it unnecessary for the writer to supply supplementary details from his own memory or from personal records.

An exception to all this exists in some cases in preparing reports for publication where the expense or available page allowance necessitates condensation. But even in such cases the full and detailed record should be made, and the published report should refer

to it in a way that will enable any interested reader to learn where he can consult it.

5. Publication. Not many research reports are of sufficient general interest to warrant publication in complete form, but most investigations that are well done should warrant publication at least as articles or summaries. Several suggestions may be made: (1) It is well not to rush into print without some actual substance to report, and not to publish half-baked or ill-considered findings. (2) Only one main idea or finding should be presented in an article, particularly for the popular reader. If many findings are to be reported, many articles may be published, each on a different phase. Care, however, should be exercised not to multiply articles unnecessarily. (3) Cooperation of the research adviser in securing publication is desirable. He may either edit the article before it is sent off, or may submit it to a journal with his recommendation. Or he may even write the article from the full report and publish it jointly with the original investigator. (4) Chances of publication may be materially improved if the article is planned so as to require small space and low printing cost. Elaborate tables or expensive charts and graphs may increase the cost to a prohibitive degree. (5) The chances of publication are increased by seeking the appropriate publisher. Journals specialize in different fields, and what one would like another could not use. Articles that would not interest national journals might appeal to local or state journals, and vice versa. Much can be done also by writing the article to suit the type of readers who subscribe to the journal in which publication is sought. (6) It may be better in some instances to let another person write the article for publication, as in the case

where a journalist is called in to dress up in popular style the results of an investigation of a very abstract nature.

6. English. It is needless to say that a research report should be written in good English. How to achieve that end, however, deserves more attention. Three suggestions may be in order, as follows: (1) The writer of the report should consider the "architecture" of his English as well as the "carpentry" of it—that is, he should look to the soundness of the larger plan of organization of his report as well as to the correctness of the details of word usage. (2) He might well afford to purchase and use for reference some standard handbook on the mechanics of English, or some standard manual of style. (3) He should ordinarily have someone else read his report after him to correct such errors of English as he has missed. If he writes a very bad quality of English, he may have to employ someone to make a detailed study and to revise his report in regard to its English form.

In closing, we may say that the good research report is one which clearly describes what was done and what was found, and does this so effectively that busy readers will take time to read, think, and act upon the findings.

EXERCISES AND QUESTIONS

1. Give every reason you can for writing up the results in a full and complete report.

2. In what ways should a report that is to be published as a brief article differ from the more extensive unpublished report? Why?

3. Explain why most research is "buried" on completion, never being used by those whom it might possibly serve. How could this situation be remedied?

4. Examine a few research reports and criticize their organization, style, and content.

5. To what extent would it be possible or desirable to fit every research report into the same general set of chapter titles? Why?

6. Give every method you can for popularizing research findings.

7. Compare the booklets of directions regarding thesis form from several graduate schools with the specifications in this chapter and see how well they agree on the various points.

8. Explain why theses in different departments in a graduate school vary so greatly in content and organization.

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